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Original Article

What It Takes to Obtain a Generative Safety Culture Level in Mature Offshore Oil and Gas Companies? A Case Study of an Indonesian Mature Offshore Oil and Gas Company

[1]Mario Indra Wibawa, [2]Santi Novani
[1,2]School of Business and Management – Institute of Technology, Bandung (SBM-ITB), Jl. Ganesha 10, Bandung, 40132, Indonesia.

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Abstract: *The factors that contribute to achieving a generative safety culture in mature offshore oil and gas companies, with a specific focus on an Indonesian mature offshore oil and gas company, are examined in this study. It investigates the impact of management commitment, safety leadership, personal attitude, communication, competency, and workplace conditions on safety compliance, safety participation, and overall safety culture performance. Through a mixed-method approach combining semi-structured interviews with safety experts and management and structured surveys of employees, the study proposes and tests a mediation model to clarify these relationships. The importance of these factors in enhancing safety behavior compliance and participation is highlighted by the findings, with new insights and strategies for safety management in the mature offshore oil and gas industry being offered.*

Keywords: *Safety culture, Offshore oil and gas, Compliance, Participation, Performance*.

I. INTRODUCTION

Explosions, fires, and oil spills are examples of major risks in the oil and gas industry. The global track record of oil and gas accidents, such as Deepwater Horizon, Piper Alpha, Ocean Ranger, and others, can be said to be the most fatal oil and gas accidents that have ever occurred in this industry (Nwankwo et al., 2022). Meanwhile, based on Indonesian oil and gas statistics for Semester I 2022 published by the Ministry of Energy and Mineral Resources of Indonesia, there were 75 upstream work accidents with the highest number of accidents being in the light category. Meanwhile, downstream, 46 work accidents were reported, which were also dominated by minor accidents (Directorate General of Oil and Gas, 2022).

Domestic accidents and fatalities also occurred in the first quarter of 2023, namely in the form of fires at the Refinery Unit (RU) II Dumai Refinery and the Plumpang Fuel Oil Terminal (Cornelius et al., 2024). A number of other accidents have also occurred throughout early 2023. As of April 2023, SKK Migas reported that 36 workers in the national upstream oil and gas industry had experienced work accidents (Lestari & Prasetya, 2023).

In Indonesia's oil and gas industry, the occurrence of work accidents is influenced by various elements, such as safety culture effectiveness and the difficulties presented by aging infrastructure in mature oil and gas fields. This escalation highlighted critical weaknesses in the prevailing safety culture performance (Sugiarto, 2023).

Safety researchers have been interested in safety culture since the Chernobyl nuclear accident in 1986; the International Nuclear Safety Advisory Group (INSAG) coined the term "safety culture" to emphasize the significance of management and organizational variables in safety. It was at this time that safety culture was first linked to an accident investigation and evaluation. (Cox & Flin, 1998). Organizational culture includes safety culture, and it is becoming more widely accepted to evaluate corporate safety culture in order to improve safety performance (Guldenmund, 2000).

In general, compliance with safety regulations relates to the necessary safety procedures that people must follow in order to guarantee workplace safety. (Griffin & Neal, 2000). In the offshore oil and gas field, failing to adhere to safety behaviors increases safety risks and raises the likelihood of accidents among workers, contributing to the hundreds of thousands of fatalities that occur each year due to safety accidents (Wingate et al., 2023). The leading causes of death include falls, electric shocks, and collisions due to violations of safety regulations (Liwång, 2020). Thus, within the offshore oil and gas industry, enhancing worker safety behavior compliance and ensuring worker safety have become critical strategic priorities for the industry's sustainable development (Dahl & Olsen, 2013).

To improve workers' safety culture performance, the studies have carried out specific studies. From research perspectives, there are many research have studied safety culture performance issues mainly from the perspective of employees and employers (Ye et al., 2022). The previous research has primarily investigated the influence of three levels of factors: individual, leadership, and organizational (Linnenluecke & Griffiths, 2010). Regarding research methods, the literature on improving employees' safety culture performance predominantly features qualitative approaches, with a few studies employing expert scoring methods for basic quantitative analysis (Koehler-Warren, 2023).

Research indicates that in safety incidents resulting from non-compliant operational behaviors, inadequate worker involvement in safety activities is a significant factor contributing to operational violations (Chmiel et al., 2017). In the realm of operational management, engagement in safety-related activities is often denoted by the term "safety participation." According to social norms theory, a "norm-oriented organization" typically embodies behaviors deemed acceptable and suitable. The organizational environment shaped by norm-orientation can influence individuals' behaviors within the organization (Blay et al., 2018). Neal and Griffin define safety participation as "behaviors that indirectly help ensure a person's personal safety, yet foster the development of a safety-supportive environment" (Neal & Griffin, 2006), as employee safety participation falls within the realm of individual assimilation into the organizational setting, it also notably influences the compliance of employee behavior. Yet, in the current literature, for instance, Neal and Griffin's safety performance framework, "safety behavior" is segmented into "safety participation" and "safety compliance" as parallel sub-dimensions, overlooking the potential influence of safety participation on safety culture performance (Neal et al., 2000). Subsequently, the authors conducted further research based on this paradigm, with numerous studies examining safety participation as a variable to be explained rather than one that explains other phenomena. (Thurston & Glendon, 2018). Managers are confused in practice, and safety management theory is flawed because "safety participation" is very simple to implement when compared to other elements affecting safety culture performance.

To investigate how safety participation influences safety culture performance, it is crucial to elucidate the mechanism connecting safety participation and safety culture performance. In line with social learning theory, human development emerges from interactions among individuals, their environment, and society. Both the environment and society shape human conduct and people can pick up skills through observation of the world around them and social interactions (Powers et al., 2020). Hence, employees, by consistently observing and learning during safety participation, are inclined to enhance their job skills, potentially leading to improved safety behavior compliance. In management, employees' job skills are typically denoted by job competence, yet there has been limited focus on employees' job competence within engineering projects. This paper defines job competency as "the capacity to execute particular tasks and fulfill roles within one's organization" (Eraut, 1998). This idea could serve as a fundamental mechanism for elucidating the link between safety participation and safety culture performance.

Empirical data also revealed that specific factors played pivotal roles in enhancing safety performance. Improved safety training programs increased worker competency and awareness, while better communication channels ensured timely reporting and resolution of safety issues (Darbra et al., 2007).

Meanwhile, the challenges associated with ageing facilities of mature oil and fields remained significant. Many of the oil and gas installations in Indonesia were built decades ago and have since suffered from wear and tear, increasing the risk of equipment failures and accidents (Husna TR, 2018). Mature fields of oil and gas, which require more complex and often riskier extraction techniques, added another layer of difficulty to maintaining safety standards. The modernization of facilities and adherence to rigorous maintenance schedules were key in mitigating the risks posed by ageing infrastructure and mature fields (Babadagli, 2007).

Therefore, this study aims to determine and examine the variables that influence the performance of the safety culture in the established offshore oil and gas sector. Additionally, this study aims to determine which factors most significantly impact safety culture performance in these environments. Furthermore, the research seeks to develop and propose safety performance improvement strategies that the oil and gas industry should implement to support the sustainability of its business operations.

The primary research steps included the following: (1) First, a theoretical formulation and literature review were used to suggest a mediation model; (2) Following that, semi-structured interviews were conducted with the management team of an Indonesian company and safety specialists and (3) Lastly, a structured survey was administered to the company's employees to test the research hypothesis.

This research contributes in three key areas: (1) moving beyond superficial qualitative analysis, we employed empirical analysis to quantitatively examine the relationships among management commitment, safety leadership, personal attitude, communication, competency, workplace conditions, safety compliance, safety participation, and safety culture performance; (2) By identifying the most contributing factors affecting safety culture performance, we offered a fresh perspective for research in

this area; and (3) Practically, to enhance safety culture performance in mature offshore oil and gas fields, we devised new guiding strategies beneficial to the management team.

II. LITERATURE REVIEW AND HYPOTHESES

A) The Impact of Management Commitment on Workers' Safety Compliance and Safety Participation

Previous studies have demonstrated that management's commitment to safety significantly influences employees' attitudes and behaviors concerning risk (Cheyne et al., 1998) (Cohen, 1977) (DeJoy et al., 2004). Employees are made aware of the value of safety to the company by a dedicated manager who actively participates in safety initiatives and shows concern for working conditions. Consequently, employees adhere to regulations, implement appropriate safety measures, and actively engage in meetings and activities aimed at enhancing their workplace.

There are a lot of safety culture concepts out there. Grote and Kunzler presented a conceptual social-technical model without a means for evaluation. (Grote & Künzler, 2000). Cooper introduced a reciprocal model of safety culture (Cooper & Phillips, 2004), which was based on Bandura's model of reciprocal determinism (Bandura, 2002). This paradigm acknowledges that behavior, contextual structure, and people (psychological) are important components in creating an organizational safety culture. 'People' in this context can refer to individual safety perceptions like manager commitment and employee safety attitude; 'organization scenario' can refer to a safety oversight structure; and 'behavior' can refer to everyone's safety performance.

Compliance, involvement, and management commitment all had an impact on how well employees were perceived to be performing. It takes a strong manager's dedication to safety to promote safety performance. A greater level of executive commitment to safety, demonstrated by worries about employees' involvement in safety-related activities, will directly encourage employee safety involvement. (Su, 2021).

Accordingly, the authors proposed hypotheses 1-a and 1-b:

Hypothesis 1-a (H1-a). The commitment of management has a substantial and positive influence on workers' safety compliance.

Hypothesis 1-b (H1-b). The commitment of management has a substantial and positive influence on employees' participation in safety initiatives.

B) The Impact of Safety Leadership on Workers' Safety Compliance and Safety Participation

A large body of research suggests that supervisor safety-related behaviors are crucial for forecasting employee safety adherence and security-related outcomes (Hofmann & Morgeson, 2004). For example, according to Zohar and Luria (Zohar & Luria, 2003), Adopted organizational safety policies deal with managers' and workers' actual implementation and performance of safety regulations and procedures. Put another way, when it comes to assessing the actual importance of safety within a company, deeds speak louder than words. In accord with this notion, Probst and Brubaker (Probst & Brubaker, 2001) proposed that extrinsic safety motivation (i.e., supervisor enforcement) would be related to employee safety compliance at work. The concept of extrinsic safety motivation concerns how workers view their managers' application of safety regulations, particularly how much they encourage compliance and penalize failure to comply. It was found that employees with low extrinsic safety motivation (i.e., when supervisors did not enforce safety policies) exhibited lower levels of safety compliance and were more prone to workplace injuries and accidents. It was demonstrated that this feature of the implemented safety policy affected the safety results. More recently, Fugas (Fugas et al., 2012) concentrated on a mix of cognitive and social factors and discovered that workers' compliance safety behaviors are predicted by supervisors' injunctive safety norms and perceived behavioral control. In fact, Clarke's later meta-analysis (Clarke, 2013) indicated that while leadership that transforms was more likely to be associated with discretionary safety behaviors, transactional safety leadership—that is, an emphasis on supervisor enforcement—was more likely to foresee compliance with safety standards.

Accordingly, the authors proposed hypotheses 2-a and 2-b:

Hypothesis 2-a (H2-a). Safety leadership has a significant positive impact on worker’s safety compliance.

Hypothesis 2-b (H2-b). Safety leadership has a significant positive impact on worker’s safety participation.

C) The Impact of Personal Attitude on Workers' Safety Compliance and Safety Participation

A worker who has a strong safety mindset will be more inclined to observe safety procedures for their own protection. Worker's safety attitudes also played a key role in encouraging worker's participation and compliance with safety procedures (Su, 2021).

Accordingly, the authors proposed hypotheses 3-a and 3-b:

Hypothesis 3-a (H3-a). Personal attitudes of individuals play a significant and beneficial role in shaping workers' compliance with safety protocols.

Hypothesis 3-b (H3-b). Personal attitudes of individuals play a significant and beneficial role in shaping workers' participation in safety programs.

D) The Impact of Communication on Workers' Safety Compliance and Safety Participation

The practice of encouraging mutual understanding and two-way communication about the organization's safety and goal needs between the employer and employees is known as safety communication (Hassan & Loong, 2017). People, tasks, procedures, and technologies can interact purposefully and constructively through communications to achieve corporate goals, including positive safety performance. Previous research findings indicate that several factors can impact an organization's safety performance, with effective communication being identified as a crucial factor among them (Abdullah et al., 2009) (Hofmann et al., 2017) (Jin et al., 2015) (Kouabenan et al., 2015). Efficient communication is essential for establishing a workplace free from injuries. Despite most injuries resulting from risky behaviors, employees frequently hesitate to offer safety-related feedback to their colleagues (Lee & Chen, 2018).

Clear communication allows management to swiftly identify workplace hazards and correct errors, leveraging an effective system of communication and feedback within the organization (Vredenburgh, 2002). Previous studies have unveiled the connection between safety communication, feedback, and safety outcomes (Mearns et al., 2003) (Ali et al., 2009) (Cigularov et al., 2010). Typically, supervisors bear the primary responsibility for informing employees about health and safety protocols, ensuring they receive comprehensive information on the subject. Safety effectiveness is significantly correlated with managers and teammates having effective communication (Kouabenan et al., 2015). Effective communication also has a positive and significant result in reducing accident rates (Hofmann et al., 2017).

Likewise, earlier studies showed that feedback and communication play a major role in lowering the injury rate (Ali et al., 2009). To sum up, safety communication was identified as a mechanism for enhancing safety performance, reducing accident rates, and identifying potential safety concerns in the workplace. By offering solid recommendations to enhance safety-related communication, a business can improve its performance in terms of safety. The workplace can be made safer by more effectively giving and receiving safety feedback, which includes rewards and constructive criticism for at-risk conduct.

Accordingly, the authors proposed hypotheses 4-a and 4-b:

Hypothesis 4-a (H4-a). Communication has a significant positive impact on worker’s safety compliance.
Hypothesis 4-b (H4-b). Communication has a significant positive impact on worker’s safety participation.

E) The Impact of Competency on Workers' Safety Compliance and Safety Participation

In the context of agency theory, the leadership at the highest level within a company can be perceived as principals, whereas frontline employees can be considered agents (Zin & Ismail, 2012). As demonstrated in prior studies, when the principal mandates particular behaviors from the agents, which are advantageous to the principal but burdensome for the agents, challenges may arise concerning the agents' adherence to these behaviors (Li et al., 2022). When encountering identical demands for safety culture performance, employees possessing greater job competency frequently require less effort in terms of time, energy, physical fitness, etc., to fulfill these compliance requirements (Shevchenko et al., 2020). This implies that enhancing job competence can diminish the expenses for employees in fulfilling mandated behaviors, thereby potentially elevating the level of safety culture performance substantially.

Currently, the authors have engaged in initial deliberations concerning job competence and safety matters. Based on qualitative analysis, they contend that safety knowledge and skills are pivotal elements influencing employee safety culture performance. Neal and Griffin's research survey revealed a positive correlation between employees' knowledge and skill levels and their adherence to safety compliance behaviors (Neal & Griffin, 2002). Yapp and Fairman have demonstrated by a quantitative study that workers' ignorance of critical safety issues is a major cause of violations (Yapp & Fairman, 2006).

Accordingly, the authors proposed hypotheses 5-a and 5-b:
Hypothesis 5-a (H5-a). Competency has a significant positive impact on worker’s safety compliance.
Hypothesis 5-b (H5-b). Competency has a significant positive impact on worker safety participation.

F) The Impact of Workplace Conditions on Workers' Safety Compliance and Safety Participation

According to earlier research, a hazard is any physical situation that has the potential to endanger human life, damage property, harm the environment, or any combination of these (Jones, 1992). It can also be summed up as anything that has the capacity to do damage. Many researchers have discovered a strong correlation between employees' conduct and the perceived degree of occupational hazards and the likelihood of mishaps (Ford & Tetrick, 2011; Rundmo, 1992; Seo, 2005; Simmonds & Shafai-Sahrai, 1977; Tomas et al., 1999).

Previous studies examine the relationship between occupational dangers and two attitudinal outcomes: organizational affiliation and psychological autonomy. They also examine the impact of these two factors on the performance of safety (Ford & Tetrick, 2011). Previous research indicates that hazardous work environments lead employees to perceive less organizational concern for their well-being, resulting in diminished concern about their work outcomes and their impact on the organization. Consequently, workplace risks negatively impact workers' psychological empowerment, sense of belonging to their company, and, ultimately, their safety practices. Workers who have a sense of belonging to their organization are more driven to meet targets, enhance organizational performance, and contribute to the well-being of the organization as a whole. These workers typically act in a way that enhances the environment of the company, collaborates to meet goals for both individual and organizational safety, and engage in extracurricular activities that can develop into corporate citizenship activities (Ford & Tetrick, 2011). All of this increases worker safety. Workers who feel empowered and in control of their work are also more likely to feel influential inside the business because they view themselves as change agents and have the self-assurance to start safety-related change initiatives. They are, therefore, more inclined to participate in safety-related activities. Additionally, these workers are more inclined to encourage their colleagues to practice safety and to speak up about their circumstances at work (Ford & Tetrick, 2011).

Simultaneously, occupational hazards can impede employees' capacity to perform their duties, particularly when risks cause disruptions in tasks. This diminishes workers' sense of control over their jobs and workplace, which in turn diminishes psychological empowerment and the standard of the worker-employer bond. (Ford & Tetrick, 2011).

Additionally, the performance of employees can be impacted by environmental factors like dust, vibration, temperature, illumination, and sound at work (Kahya, 2007). Under such circumstances, employees face heightened challenges in maintaining focus on their tasks, potentially resulting in reduced productivity, diminished quality, and/or increased physical and emotional stress. The same author contends that unfavorable surroundings hinder colleagues' ability to collaborate to find solutions to tasks. Furthermore, previous research indicates that risks, hazards, physical demands, and complexity are barriers that lessen workers' willingness to follow safety procedures, engage in safety activities, or feel satisfied (Nahrgang et al., 2011).

Given the foregoing, it stands to reason that a positive work atmosphere and a sense of minimal occupational hazards will encourage employees' adherence to safety procedures, involvement in safety initiatives, and support of their coworkers.

Accordingly, the authors proposed hypotheses 6-a and 6-b:
Hypothesis 6-a (H6-a). Workplace conditions have a significant positive impact on worker’s safety compliance.
Hypothesis 6-b (H6-b). Workplace conditions have a significant positive impact on worker’s safety participation.

G) The Impact of Workers' Safety Compliance and Safety Participation, as Mediating Role, on Safety Culture Performance

Employee compliance and involvement are essential for the proper growth of the company's technical system, as human factors have a significant impact on the safety and effectiveness of the organization (Donald & Young, 1996). The last line of defense against risk is the workforce, and it is up to them to act in a way that prevents material and personal harm (Hofmann & Stetzer, 1996). In the same way, when staff members participate, absenteeism decreases, and employee satisfaction and motivation increase because they perceive themselves as valuable members of the company, and their bosses value their ideas and contributions. Employees are more devoted to and associated with their company in this way, furthering the goals of the latter (Vecchio-Sadus & Griffiths, 2004).

According to the discussion in Sections 2.1, 2.2, 2.3, 2.4, 2.5, and 2.6, we believe that management commitment, safety leadership, personal attitude, communication, training or competence, and workplace condition can not directly affect safety culture performance but indirectly through the "bridge" of safety compliance and safety participation Existing research has indicated that safety involvement combined with vocational education and training can equip employees with professional expertise and knowledge, enhancing their work proficiency. Consequently, safety participation can be seen as a "platform" for employees to acquire job-related knowledge and skills, thus enhancing their job competency (Hardison et al., 2014). Conversely, certain studies have revealed that enhancing employee job competency enhances their adaptability in the workplace, thereby enhancing their safety compliance behavior. In other words, job competency significantly influences employee behavior compliance (Shevchenko et al., 2020). In summary, job competence first has a positive impact on safety participation, and subsequently, safety participation has a positive impact on safety culture performance.

Thus, the authors proposed hypotheses 7-a and 7-b:
Hypothesis 7-a (H7-a). Safety compliance, as a mediating role, has a significant positive impact on safety culture performance.
Hypothesis 7-b (H7-b). Safety participation, as a mediating role, has a significant positive impact on safety culture performance.

Thus, we put forward the conceptual model outlined in Figure 1.

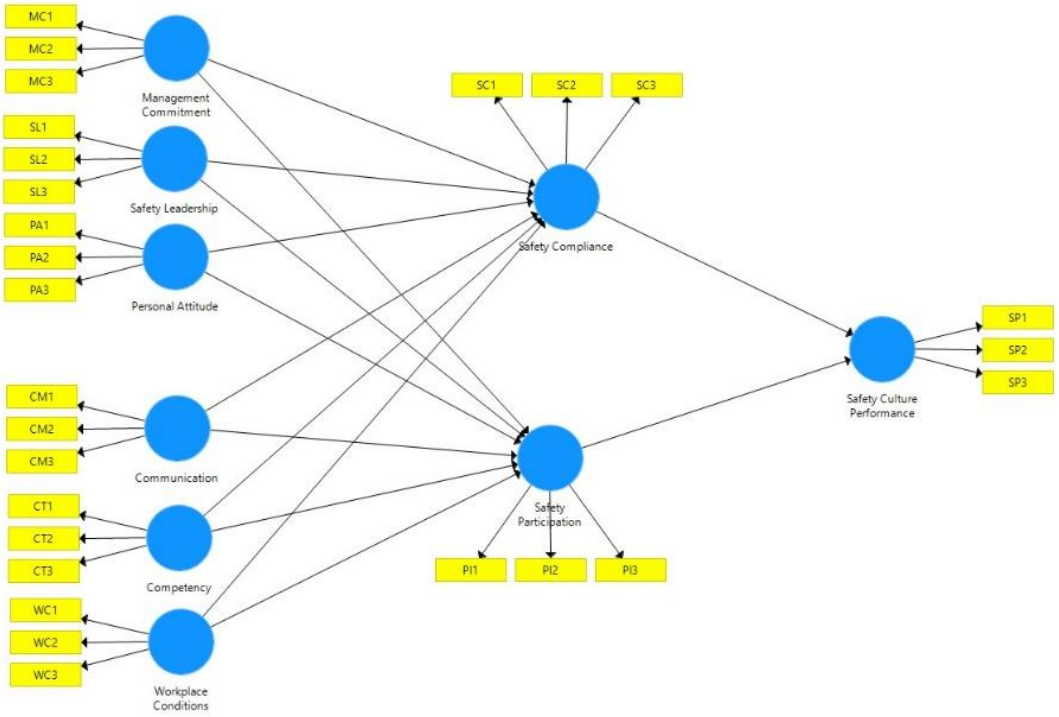

Figure 1. Theoretical model

III. METHODS

A) Data Collection

In this study, a blend of qualitative analysis and quantitative research was employed to investigate the interconnection among management commitment, safety leadership, personal attitude, communication, competency, workplace conditions, safety compliance, safety participation, and safety culture performance. Upon finalizing the qualitative analysis through theoretical derivation and literature review, we proceeded to gather data through individual exploratory semi-structured interviews. These interviews were conducted with one vice president, one general manager, two operations managers, one safety manager, three field superintendents, and three safety experts from an Indonesian Offshore Oil and Gas Company.

The interview conversations revolved around accident causation and worker attitudes regarding on-site safety. The primary question posed was, “What factors contribute to safety culture performance in mature offshore oil and gas companies?”. Follow-up probing questions covered areas such as safety culture performance, management commitment, safety leadership, personal attitude, communication, competency, workplace conditions, safety compliance, safety participation, and what suggestions they had for improvement of safety culture performance. All interviews were recorded with the permission of the participating responders.

After conducting the exploratory interviews, a pilot study questionnaire was developed and reviewed by twenty participants (which included the five from the exploratory interviews). The questionnaire underwent revisions based on feedback, and the final version was then distributed to appropriate personnel (mainly operation managers and site superintendents), who subsequently shared it with their staff as per prior arrangements. There were 27 questions in each questionnaire that had to do with the study variables, namely, management commitment (V1), safety leadership (V2), personal attitude (V3), communication (V4), competency (V5), workplace conditions (V6), safety compliance (V7), safety participation (V8), and safety culture performance (V9).

The findings from the exploratory interviews and the pilot study have solidified the research framework and laid the groundwork for the main study. Following this, the final questionnaire was disseminated to pertinent site managers, who subsequently passed it on to their respective employees.

Each attitudinal query was assessed utilizing a five-point Likert scale, offering response choices spanning from 'strongly agree' to 'strongly disagree'. Participants were encouraged to express their opinions favorably or unfavorably regarding statements categorized under various headings. For instance, the attitudinal statement regarding the influence of competency on

safety compliance was assessed by assigning a score of 1 to those strongly disagreeing, 2 to those disagreeing, 3 to those neither agreeing nor disagreeing, 4 to those agreeing, and 5 to those strongly agreeing.

The external validity of most empirical studies is questioned since they restrict their sample to a single business inside a narrow industry (Silva et al., 2004). Therefore, in order to maximize the generalizability of the findings from this study, we took into account that the total population size of the offshore oil and gas company in this case study is approximately 2500 employees. Then, considering a maximum error of 5% at a 95% confidence level, we computed the number of replies required to guarantee that the respondents would be representative of the entire population.

B) Analytical Approach

In total, 1630 questionnaires were sent, of which all returned with use, representing 65,2% of the total population. After that, every variable (i.e., question) in the questionnaire was coded and assigned a number. The data was then analyzed utiizing the Structural Equation Model (SEM).

In contrast to traditional regression analysis approaches like linear regression, SEM offers greater flexibility by allowing the simultaneous testing of multiple equations (Memon et al., 2021). Therefore, SEM is better suited for this research. Covariance-based SEM, or so-called CB-SEM, and partial least squares SEM or so-called PLS-SEM, are the two main types of SEM. PLS-SEM allows researchers to handle diverse structures and indicators, and its results are more precise than other SEM forms when the model involves more than two variables (Hair et al., 2019). Moreover, PLS-SEM can more effectively address data processing needs and modify the relationships between variables (Hair et al., 2019). Hence, PLS-SEM was deemed the most appropriate analytical approach for this study.

For this study, the analysis tool chosen was SmartPls 3.0 Software, developed by SmartPLS based in Bommingstedt, Germany. SmartPls offers streamlined analysis features and is user-friendly. Additionally, its interface is easy to navigate (Sarstedt et al., 2017). As a result, this study drew on the method of Zhao (Zhao et al., 2010), and employed the PLS-SEM model for empirical analysis (Marcoulides et al., 2009). The following steps were involved in the PLS-SEM data processing: assessment of the first model measurement, assessment of the model's subsequent variable removal, and an assessment of the structural model Using PLS-SEM for structural equation modeling hypothesis testing.

IV. RESULT

To test the research model, we adopted a two-step approach (Anderson & Gerbing, 1988). Performing a confirmatory factor analysis is the first step. The validity and reliability of the research can be confirmed in this phase. In order to evaluate the research hypotheses, the structural equation model analysis is the second phase.

A) Indicator Reliability and Validity

To finish the structural model analysis, it is important to confirm the validity and reliability of the latent variables. The numerous validity and reliability criteria that we examine and record when performing a PLS-SEM are displayed in the following tables (see Table 1).

Table 1. Results Summary for Reflective Outer Model

Latent variables	Indicators	Loading	Composite Reliability	AVE
Management Commitment	MC1	0.941	0.961	0.893
	MC2	0.947		
	MC3	0.947		
Safety Leadership	SL1	0.942	0.967	0.907
	SL2	0.955		
	SL3	0.960		
Personal Attitude	PA1	0.924	0.963	0.898
	PA2	0.957		
	PA3	0.962		
Communication	CM1	0.945	0.968	0.910
	CM2	0.954		
	CM3	0.963		
Competency	CT1	0.957	0.973	0.923
	CT2	0.965		
	CT3	0.959		
Workplace Conditions	WC1	0.934	0.961	0.891
	WC2	0.947		
	WC3	0.051		
Safety Compliance	SC1	0.954		0.919

	SC2	0.960	0.971	
	SC3	0.962		
Safety Participation	PI1	0.946	0.967	0.908
	PI2	0.954		
	PI3	0.958		
Safety Culture Performance	SP1	0.962	0.973	0.924
	SP2	0.960		
	SP3	0.961		

First, let us look at "Composite Reliability." As can be observed, every indicator value is greater than 0.6, indicating that latent variables have a high degree of internal consistency dependability. The AVE (Average Variance Extracted) of each talent variable is assessed in order to verify the validity of convergent validity. The analysis revealed that all AVE values exceed the acceptable threshold of 0.5, thereby confirming convergent validity.

To confirm the discriminant validity, we followed the Fornell & Larcker Method (Fornell & Larcker, 1981). The approach proposes that the square root of AVE for each latent variable can establish discriminant validity if it surpasses the correlation values with other latent variables. To accomplish this, a table is generated where the square root of AVE is manually computed and highlighted in bold on the diagonal. The correlation between the latent variables is situated in the lower left triangle of the table (refer to Table 2) and is taken from the "Latent Variable Correlation" part of the default analysis.

Table 2. Fornell-Lacker Criterion Analysis for Discriminant Validity

	#1	#2	#3	#4	#5	#6	#7	#8	#9
#1 Management Commitment	1.000	0.780	0.723	0.721	0.740	0.693	0.749	0.698	0.737
#2 Safety Leadership	0.780	1.000	0.773	0.756	0.752	0.728	0.786	0.745	0.784
#3 Personal Attitude	0.723	0.773	1.000	0.779	0.784	0.768	0.795	0.769	0.789
#4 Communication	0.721	0.756	0.779	1.000	0.792	0.780	0.764	0.766	0.757
#5 Competency	0.740	0.752	0.784	0.792	1.000	0.794	0.802	0.762	0.809
#6 Workplace Conditions	0.693	0.728	0.768	0.780	0.794	1.000	0.776	0.754	0.790
#7 Safety Compliance	0.749	0.786	0.795	0.764	0.802	0.776	1.000	0.828	0.881
#8 Safety Participation	0.698	0.745	0.769	0.766	0.762	0.754	0.828	1.000	0.825
#9 Safety Culture Performance	0.737	0.784	0.789	0.757	0.809	0.790	0.881	0.825	1.000

The latent variables 'Management Commitment' and 'Safety Culture Performance' AVE are found to be smaller than the correlation values in the column. The latent variables in the matrix exhibit a similar observation. The outcome shows that the validity of partial discriminant analysis is widely recognized.

B) Structural Equation Modeling Result

T-statistics to test the significance of both the inner and outer models can be produced by the PLS program through a technique known as bootstrapping. This process involves taking a large number of subsamples (for example, 5000) from the original sample with replacement to produce bootstrap standard errors. These errors provide approximate T-values for testing the significance of the structural path. The bootstrapping results approximate data normality. Once the bootstrapping process is finished, the results can be obtained as follows.

Table 3. Results of PLS-SEM

Paths	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P-value
H1-a: Mgmt Commitment → Safety Compliance	0.124	0.124	0.044	2.846	0.005
H1-b: Mgmt Commitment → Safety Participation	0.058	0.060	0.042	1.374	0.170
H2-a: Safety Leadership → Safety Compliance	0.199	0.203	0.053	3.732	0.000
H2-b: Safety Leadership → Safety Participation	0.157	0.157	0.062	2.537	0.011
H3-a: Personal Attitude → Safety Compliance	0.201	0.201	0.049	4.102	0.000
H3-b: Personal Attitude → Safety Participation	0.207	0.204	0.057	3.650	0.000
H4-a: Communication → Safety	0.063	0.064	0.042	1.489	0.137

Compliance					
H4-b: Communication → Safety Participation	0.192	0.192	0.062	3.094	0.002
H5-a: Competency → Safety Compliance	0.222	0.217	0.048	4.665	0.000
H5-b: Competency → Safety Participation	0.152	0.150	0.061	2.488	0.013
H6-a: Workplace Cond. → Safety Compliance	0.164	0.165	0.047	3.512	0.000
H6-b: Workplace Cond. → Safety Participation	0.170	0.172	0.053	3.195	0.001
H7-a: Safety Compliance → Safety Culture Perform.	0.632	0.632	0.056	11.183	0.000
H7-b: Safety Participation → Safety Culture Perform.	0.301	0.301	0.059	5.098	0.000

Upon examining the path coefficient within the inner model, we can explore the outer model by checking the T-statistic in the "Outer Loading (Means, STDEV, T-Values)" window. As presented in Table 3, twelve of the T-Statistics are larger than 1.96, so we can say that the outer model loadings are highly significant. So H1-a, H2-a, H2-b, H3-a, H3-b, H4-b, H5-a, H5-b, H6-a, H6-b, H7-a and H7-b are adopted. While H1-b and H4-a are rejected. All of these results complete a basic analysis of PLS-SEM in our research. PLS-SEM result is shown in Figure 2.

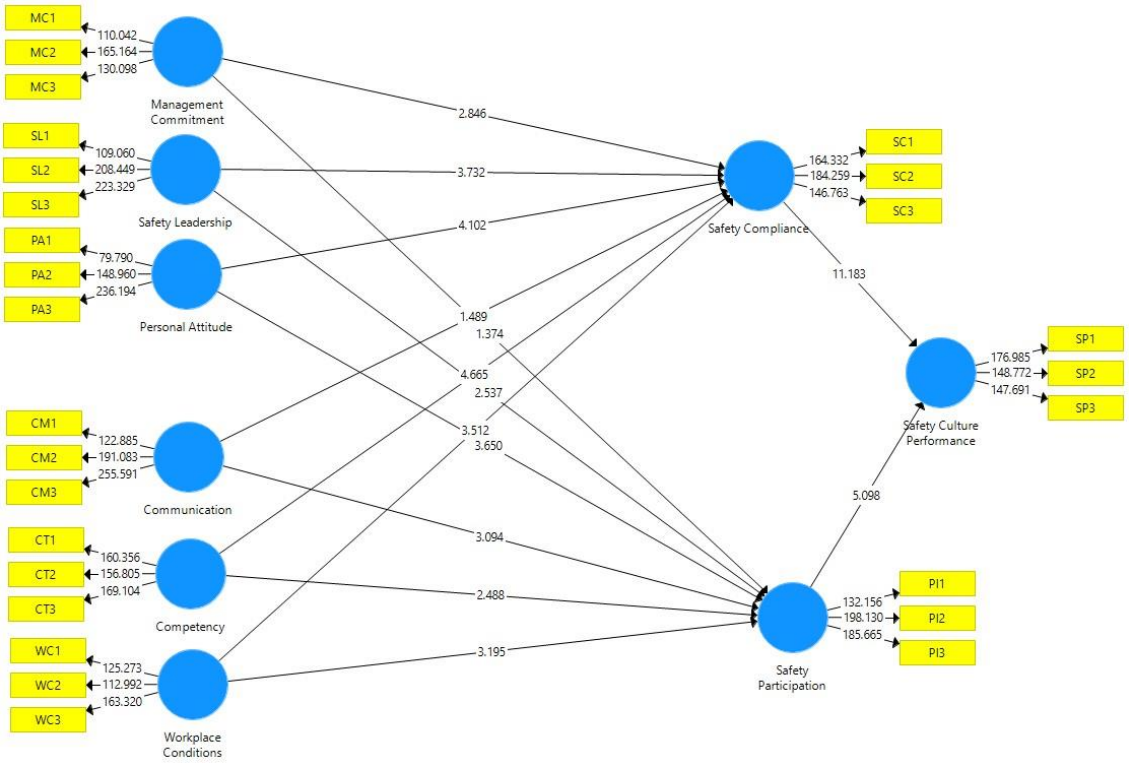

Figure 2. Path Model and PLS-SEM Estimate

V. CONCLUSION AND IMPLICATION

This research aimed to clarify the relationship among management commitment, safety leadership, personal attitude, communication, competency, workplace conditions, safety compliance, safety participation, and safety culture performance. The empirical analysis found that (1) management commitment had a significant positive impact on safety compliance; (2) safety leadership had a significant positive impact on safety compliance and safety participation; (3) personal attitude had a significant positive impact on safety compliance and safety participation; (4) communication had a significant positive impact on safety participation; (5) competency had a noteworthy improvement in safety participation and compliance; (6) the quality of the workplace environment significantly influenced both safety compliance and participation in a positive manner; (7) safety compliance and safety participation played an intermediary role between management commitment, safety leadership, personal

attitude, communication, competency, workplace conditions, safety compliance, safety participation, and safety culture performance.

Theoretically, this research discovered a new path for management commitment, safety leadership, personal attitude, communication, competency, and workplace conditions to influence safety culture performance and enriched safety management theory for use in mature offshore oil and gas companies. This study offers practical insights into safety evaluation standards and delivers effective recommendations and guidance for enhancing the safety culture performance within the oil and gas sectors.

The oil and gas industry in Indonesia has made considerable advancements in enhancing safety culture performance. However, the ongoing challenges posed by ageing facilities and mature fields require continuous attention and investment. By leveraging empirical data to guide safety strategies and addressing the unique risks associated with older infrastructure, the industry can work towards achieving a safer working environment for all employees.

The industry recognized that addressing these challenges was crucial for sustaining the downward trend in work accidents. Focusing on modernizing facilities, implementing advanced safety technologies, and conducting regular maintenance is essential to mitigate the risks associated with ageing infrastructure. Besides, specialized training programs need to be developed to equip workers with the skills needed to operate in mature fields safely.

While this research offers distinctive value, it also presents specific limitations that offer valuable avenues for future researchers. Primarily, due to constraints within the current research scope, the study samples were solely acquired from a single offshore oil and gas company in Indonesia. Furthermore, statistically speaking, errors are inherent in any sample; thus, future researchers should employ samples comprising employees from diverse industries. Additionally, it is worth noting that there could exist a reverse causal link between management commitment, safety leadership, personal attitude, communication, competency, workplace conditions, safety compliance, safety participation, and safety culture performance, which are currently designated as independent, intermediary, and dependent variables. In forthcoming studies, we aim to assess variables across multiple time intervals to address the issue of reverse causation more effectively.

Finally, besides management commitment, safety leadership, personal attitude, communication, competency, workplace conditions, and safety compliance, there may be other factors affecting safety culture performance. Consequently, future studies may incorporate additional variables to construct a more intricate model.

VI. REFERENCES

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