



Analysis of Organizational Safety Resilience in Indonesia's Oil and Gas Industry

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Abstract

Background: Severe accidents in Indonesia's oil and gas industry resulting in fatality and property damage still show an upward trend. Organizational safety resilience approach is required to improve the industry's ability to mitigate such accidents, learning from it and anticipating future threats. **Objective:** The study performed analysis of organizational safety resilience qualities (respond, learn, anticipate and monitor) at oil and gas sector in Indonesia. **Methods:** A cross-sectional design of mixed method quantitative and qualitative research was conducted through survey approach using questionnaire followed with interview of employee representatives. **Results:** The result reveals that all qualities have achieved high score of more than three in scale of four with ability to respond has the highest level (3.53) while ability to learn has the lowest one (3.23). However, there are variables in each quality with low score such as access to HSE performance statistic (3.07) and information dissemination (3.15). Priority conflict of safety and production as well as impression that safety is an administrative exercise rather than critical aspect to ensure safe operation are still imminent concern. **Conclusion:** Continuous improvement on lower score variables along with ability to learn and anticipate will help in boosting the resilience level. Future longitudinal study is recommended to explore resilience level variation over longer time frame which will be critical for enhancing resilience quality in the industry.

Keywords: Safety resilience, Resilience engineering, Resilience qualities, Safety II

What was Known

- Oil and gas industry is high-risk organization that need to be resilient to ensure its sustainability
- Limited prior studies on measurement of organizational safety resilience in Indonesian oil and gas industry

What's New and Next

- This study measures organizational safety resilience level of oil and gas industry in Indonesia
- Findings will guide improvement required to enhance resilience level of the industry

Introduction

Organizations are becoming more complex and vulnerable to threats in form of incident, disaster or crisis that could endanger their continued existence ⁽¹⁾. Therefore organizations needs to cope with its complexity to be able to manage the threat ⁽²⁾. Consequently, in addition to preventing undesirable or unexpected events which is the objective of current safety practice (Safety I), organization must be able to function well in both expected and unforeseen circumstances, so that the number of desired and acceptable results is as high as possible (Safety II)m ^(3,4). This requires organizations to have critical ability such as creative, efficient, competitive and fast-paced to manage its internal and external risks ⁽⁵⁾. Here is where resilience becomes new approach to ensure organization can function properly in those circumstances by performing proactive process rather than relies solely on reactive barriers and defenses to prevent failures and reduced risks⁽⁶⁾.

Organizational safety resilience is capability of organizations to sustain disturbance and continue to operate in difficult condition ⁽⁷⁾. Resilient organization will be able to compensate disruption without losing control and can return to safe state quickly ⁽⁸⁾. Hollnagel proposed four qualities of resilient organization consisting of ability to respond, learn, anticipate and monitor ⁽⁹⁾. A resilient organization should be capable of responding disruption such as incident or emergencies and extract lessons from them. The organization should also be capable to foresee potential challenges by evaluating possible future disruptions and monitoring what happens outside and inside the organization to improves organization's potential to cope with possible near-term disturbance.

Oil and gas sector that extract or process hydrocarbon are those among high-risk industry with devastating consequences once an incident occurred ⁽¹⁰⁾. The impact of such event can cause not only human and property loss but also potential community disruption and environmental

extensive damage. The well-known Mega Disaster of Deep Water Horizon explosion and oil spill accident in 2010 is an example of such consequence ⁽¹¹⁾. It is therefore critical for oil and gas industry to have sufficient resilience qualities to mitigate, manage and anticipate its high risk in order to prevent the recurrence of such disaster. Studies on resilience ability of oil and gas industry have been conducted in various facilities such as oil rig ⁽¹²⁾, drilling ship ⁽¹³⁾, Floating Production Storage and Offloading (FPSO) facility ⁽¹⁴⁾ and general oil and gas sector ⁽¹⁵⁾⁽¹⁶⁾. Most of it focused on exploring respond quality particularly on the emergency response capability in handling incidents. The studies indicates also that there are various indicators or qualities to measure safety resilience level.

Oil and gas industry in Indonesia has implemented safety management system according to ISO45001 as well as Indonesian oil and gas management system standard ^(17,18). However, the sector still faced major incidents resulted in fatalities and property damages. Safety performance of upstream and downstream sectors of the Indonesian oil and gas industry from 2011 to 2023 also still shows an up and down trend ^(18,19,20). The last 2024 safety report from Indonesian Department of Energy and Mineral resources even indicates increase trend in severe and fatality cases despite improvements in reducing minor incidents cases ⁽¹⁸⁾. Analysis of process safety incident in the sector revealed that there were recurring patterns of incident which include its scenarios, safeguard failures and weaknesses in process safety management systems ⁽²¹⁾. The incident investigation findings show persistent challenges related to human factors, asset integrity, safeguard design and maintenance, and the effective implementation of process safety management system elements. The pattern is also similar for other non-process safety incident with lack of safety management, operational procedure and risk management are among critical causes of the incidents. This is a critical reason for the industry to perform continuous improvement to become resilient organization. The research is aimed to analyze organizational safety resilient qualities of oil and gas industry in Indonesia and its challenges in achieving resilient organization. The indicators used for the study are four qualities of resilience (respond, anticipate, learn and monitor) proposed by Hollnagel. The findings will guide improvement required for the industry to maintain and enhance its resilience level.

Materials and Methods

1. Research Design and Data source

The study is mixed method of quantitative and qualitative research which employed cross-sectional design with combination of survey approach using questionnaire followed with interview of employee representatives. The questionnaire was also completed with feedback section for

respondent to provide feedback (comments or suggestion) on safety implementation within their organization. The respondent of the survey was purposively selected company that voluntarily willing to participate in the survey. Request for performing the study was submitted to five oil and gas companies. However, only four companies were able to participate in the study. The participant consisted of one Indonesian National Oil and Gas Company and three Multinational Companies. All companies operated both onshore and offshore facilities located in Java and Sumatera area. The study was conducted on August 2024 – June 2025.

2. Procedures

The research questionnaire was based on tailored Resilience Analysis Grid (RAG)⁽⁹⁾ which explore four resilience qualities of ability to respond, ability to learn, ability to anticipate and ability to monitor. Detail items/indicators for each quality were developed following guidance suggested by Hollnagel⁽⁴⁾ and tailored into Indonesian language. The study did not use available questionnaire which is applicable for specific or certain context that may not suitable for Indonesian oil and gas industry. 22 validated items with 4-point Likert scale and its variables for each quality are shown in Table 1. Score for each variable was average value of its item/indicator while score of each quality was average score of its variables. Reversed score for negative wording item (Item L15, L39 and A24) was calculated using the formula: reversed score = (highest possible score+1) - original score. For original score 1 then the reversed score is (4+1) – 1 equal to 4. Internal consistency analysis was performed to obtain Cronbach's alpha value while item-total correlation was conducted to inspect the questionnaire validity. Result of resilient level measurement was presented in bar and spider web chart with four level scale. All statistical analysis was performed utilizing open source Rstudio and R programming software.

Table 1 Tailored Resilience Analysis Grid (RAG) Questionnaire

Resilience Qualities	Variable	Indicator Code	Items
ability to respond	Employee involvement	R1	I understand my duties and responsibilities in the event of an incident/emergency.
		R6	I understand the incidents/emergencies that can occur in my workplace.
		R9	I am willing to be involved in incident/emergency response

Table 1 Tailored Resilience Analysis Grid (RAG) Questionnaire (Cont.)

Resilience Qualities	Variable	Indicator Code	Items
	Continuous Improvement	R2	The company always improves its incident/emergency response capabilities
	Information dissemination	R3	Managers/supervisors inform employees about incidents/emergencies that may occur in the workplace.
	Exercise and simulation	R5	The company routinely conducts simulations for responding incidents/emergencies.
	Competence	R8	I received basic training in incident/emergency response (e.g. evacuation training, use of fire extinguishers, first aid kits, etc.)
ability to learn		L11	I provide input to management to prevent incidents/emergencies from occurring.
	Employee involvement	L18	If requested, all employees including contractors are willing to be involved as members of the incident investigation team.
		L20	I provide input regarding potential incidents/emergencies that may occur in the future.
	Information dissemination	L15	Manager/supervisor does not inform workers/employees of the results of the incident investigation
	Follow up for Improvement	L17	Management only makes improvement when an incident/emergency occurs.
	Analysis of incident reports	L39	The company did not conduct comprehensive analysis regarding the causes of incidents
ability to anticipate	Information dissemination	A24	Managers/supervisors do not inform workers about potential future incidents/emergencies

Table 1 Tailored Resilience Analysis Grid (RAG) Questionnaire (Cont.)

Resilience Qualities	Variable	Indicator Code	Items
ability to monitor	Contractor involvement	A27	Contractors/subcontractors employees understand their duties and responsibilities in anticipating potential incidents/emergencies in the future.
	HSE performance reporting	M30	Management routinely disseminates HSE statistics reports to all workers.
	Management Commitment	M31	Management acts quickly to make improvements when there are reports of hazards in the workplace.
	Leading and lagging indicators	M32	The company reports HSE performance in the form of leading and lagging indicators.
	Competence	M33	I received training on hazard reporting procedures
	HSE performance reward	M36	The company provides rewards when HSE performance reaches the expected targets.
	HSE Inspection	M37	HSE inspections are carried out at the workplace in regular basis
	Access to HSE performance statistics	M40	HSE performance statistics are easily accessible to workers through electronic database/information technology system

The criteria for respondent of the study were all company personnel including contractors directly working under the company excluding supplier or vendor that provide short term goods and service only. The questionnaire was distributed online by company's safety representatives via Google and Microsoft form to all employee and contractor personnel followed with interview which was conducted at Company's Premises. Interview was conducted by one researcher to explore challenge and opportunities faced by organizations to ensure its safe operation. The interview used probing question as outlined in Table 2. Content analysis was manually performed on interview result

and feedback from respondent to identify inputs, comments, suggestion and challenges in safety implementation within their company. The analysis process consisted of the following steps:

1. Establish categories: break down the interview and feedback result into segments and assign categories.
2. Code the content: systematically label and categorize the data.
3. Analyze and interpret: identify recurring themes/topics and draw conclusions

Table 2 Probing Question for Interview

Question
1. Has the company developed emergency response tactics and strategies for every potential incident or emergency situation?
2. Does the company conduct regular audits of emergency response capability to identify potential improvements?
3. Does the company identify potential future threats?
4. Has awareness regarding potential future safety risks been integrated into all of Company's activities?
5. Has the company anticipating potential incidents in the coming years?
6. Has the company performed in depth analysis of any incident to obtain lesson learnt?

Table 3 Maturity Model for Organizational Resilience Definition

Maturity Level	Definition
Level 1 - Fragile	Organizations are vulnerable and unable to withstand disruptions, leading to their collapse or destruction.
Level 2 - Robust	Organization is capable of withstanding the identified disruptions that remain within its capacity to handle
Level 3 - Resilient	Organization is capable of withstanding all types of disruptions, including those that are unexpected or unidentified

Table 3 Maturity Model for Organizational Resilience Definition (Cont.)

Maturity Level	Definition
Level 4 - Antifragile	Organization is capable of enduring any situation, facing all unexpected and unidentified disruptions and evolving to be better, even under difficult conditions

Resilience level used for the study refers to Maturity Model for Organizational Resilience (MMOR) proposed by Ruis et al⁽²²⁾ which consist of four level i.e. fragile, robust, resilient and antifragile with fragile as the lowest level while antifragile is the highest one. Explanation of each level of MMOR is outlined in Table 3.

Results

The distribution of the Google and Microsoft form were performed by Company's HSE representatives and by the end of survey period, 246 respondents completing the questionnaire from four companies. Two companies were willing to participate in interview while the other two did not respond the request for having the interview. 20 selected personnel from two companies were interviewed. Six persons were office based while the remaining is offshore or onshore plant-based employees.

The respondents of the questionnaire include those working at office and field (offshore and onshore) with demographic characteristic outlined in Table 4. They are mainly contractor personnel (50.81%) with remaining (49.19%) is permanent employee. Most of the respondent is male personnel (90.24%).

Table 4 Demographic Characteristics of Employee (n=246)

Characteristics	n	%
Gender		
Male	222	90.24
Female	24	9.76
Employment status		
Permanent employee	121	49.19
Contractor employee	125	50.81

Table 4 Demographic Characteristics of Employee (n=246) (Cont.)

Characteristics	n	%
Working experiences (years)		
0-10	142	57.72
11-20	93	37.80
21-30	8	3.25
➤ 30	1	0.41
Missing	2	0.82
Education	20	8.13
Diploma		
Magister	43	17.48
Undergraduate	122	49.59
Highschool	61	24.80

Working experience of the respondent is mainly less than 10 years (57.72%), between 11 – 20 years (37.80%), between 21-30 years (3.25%) while the rest (0.41%) is more than 31 years experiences. 0.82% of the respondents did not provide information about their experiences.

Education background of the personnel is majority undergraduate degree (49.59%) followed by high school graduate (24.80%) with the rest is diploma and magister degree (25.61%).

Results of questionnaire reliability analysis produced Cronbach alpha score of 0.94 while standard alpha is 0.94. The reliability score if one of the items is dropped also indicates that all is greater than 0.9 (Table 5). The alpha score with 95% confidence level is 0.94 with a lower limit of 0.93 and an upper limit of 0.95, This indicates an excellent value ⁽²³⁾ which means the questionnaire is consistent and reliable.

Table 5 Cronbach alpha value if item is dropped

No	Indicator	Cronbach's Alpha	Cronbach's Standardized Alpha
1.	R1	0.936	0.938
2.	R2	0.937	0.939
3.	R3	0.935	0.937
4.	R5	0.936	0.938

Table 5 Cronbach alpha value if item is dropped (Cont.)

No	Indicator	Cronbach's Alpha	Cronbach's Standardized Alpha
5.	R6	0.936	0.938
6.	R8	0.936	0.938
7.	R9	0.935	0.938
8.	L11	0.936	0.938
9.	L15	0.938	0.940
10.	L17	0.938	0.940
11.	L18	0.938	0.940
12.	L20	0.936	0.938
13.	A24	0.936	0.939
14.	A27	0.937	0.939
15.	M30	0.935	0.938
16.	M31	0.936	0.939
17.	M32	0.935	0.937
18.	M33	0.935	0.937
19.	M36	0.937	0.939
20.	M37	0.934	0.937
21.	L39	0.938	0.940
22.	M40	0.938	0.940

Examination of item-total correction (Table 6) with critical *r*-table value of 0.13 (alpha 0.05 and 246 samples) shows that *r*.drop for all indicators are higher than critical value and also higher than common rule of thumb 0.3. This is indicating that all indicators are valid.

Table 6 Item-total correlation

No	Indicator	r.drop
1.	R1	0.63
2.	R2	0.60
3.	R3	0.70
4.	R5	0.66

Table 6 Item-total correlation (Cont.)

No	Indicator	r.drop
5.	R6	0.66
6.	R8	0.66
7.	R9	0.68
8.	L11	0.66
9.	L15	0.53
10.	L17	0.51
11.	L18	0.54
12.	L20	0.64
13.	A24	0.62
14.	A27	0.58
15.	M30	0.67
16.	M31	0.61
17.	M32	0.73
18.	M33	0.70
19.	M36	0.57
20.	M37	0.76
21.	L39	0.54
22.	M40	0.55

Summary statistic of each indicator is outlined in Table 7 while for each indicator is outlined in Table 9. All indicator has mean value in the range of 3.07 - 3.61 with standard deviation between 0.52 – 0.74. Mean value for each variable is in the range of 3.07 – 3.58 with standard deviation in the range of 0.53 – 0.74.

Table 7 Summary statistic of each indicator

No	Indicator	Mean	SD
1.	R1	3.61	0.52
2.	R2	3.58	0.53
3.	R3	3.52	0.59
4.	R5	3.57	0.55

Table 7 Summary statistic of each indicator (Cont.)

No	Indicator	Mean	SD
5.	R8	3.41	0.62
6.	R9	3.50	0.56
7.	L11	3.32	0.55
8.	L15	3.15	0.75
9.	L17	3.23	0.64
10.	L18	3.17	0.64
11.	L20	3.29	0.54
12.	A24	3.30	0.66
13.	A27	3.32	0.58
14.	M30	3.33	0.66
15.	M31	3.40	0.57
16.	M32	3.44	0.57
17.	M33	3.28	0.64
18.	M36	3.45	0.58
19.	M37	3.44	0.55
20.	L39	3.28	0.61
21.	M40	3.07	0.74

Table 8 Summary Statistic of Each Variable

Resilience Qualities	Variable	Indicator Code	Mean	SD
		R1		
	Employee involvement	R6	3.57	0.54
		R9		
ability to respond	Continuous Improvement	R2	3.58	0.53
	Information dissemination	R3	3.52	0.59
	Exercise and simulation	R5	3.57	0.55
	Competence	R8	3.41	0.62

Table 8 Summary Statistic of Each Variable (Cont.)

Resilience Qualities	Variable	Indicator Code	Mean	SD
ability to learn		L11		
	Employee involvement	L18	3.26	0.58
		L20		
	Information dissemination	L15	3.15	0.75
	Follow up for Improvement	L17	3.23	0.64
ability to anticipate	Analysis of incident reports	L39	3.28	0.61
	Information dissemination	A24	3.30	0.66
	Contractor involvement	A27	3.32	0.58
ability to monitor	HSE performance reporting	M30	3.33	0.64
	Management Commitment	M31	3.40	0.57
	Leading and lagging indicators	M32	3.44	0.57
	Competence	M33	3.28	0.64
	HSE performance reward	M36	3.45	0.58
	HSE Inspection	M37	3.44	0.55
	Access to HSE performance statistics	M40	3.07	0.74

Analysis of each resilience qualities variables is outlined in Figure 1 up to Figure 4. All variables have value in range of 3.07 – 3.58. Ability to respond has highest score on continuous improvement (3.58) variable while competence (3.41) has the lowest one. Exercise and simulation variable along with employee involvement in performing respond has also high score (3.57) while information dissemination has slightly lower score of 3.52 (Figure 1).

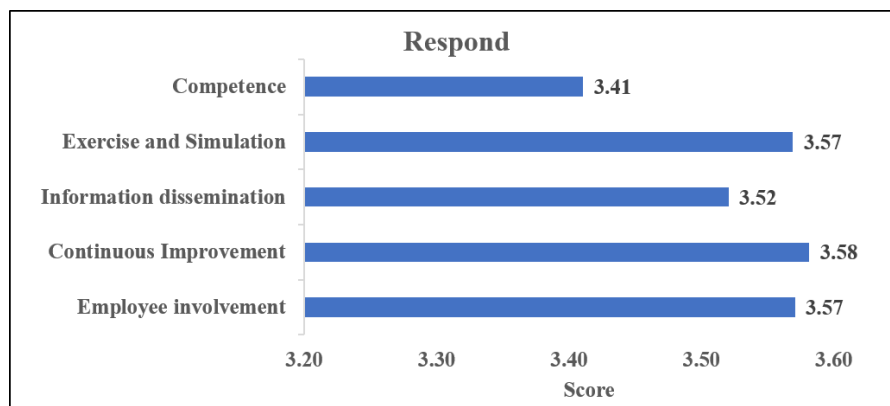


Figure 1 Score of Each Variable for Respond Quality

Ability to learn has highest score on analysis of incident report variable (3.28) while information dissemination has lowest score (3.15). Employee involvement has also high score (3.26) while follow up for improvement has slightly lower score of 3.23 (Figure 2).

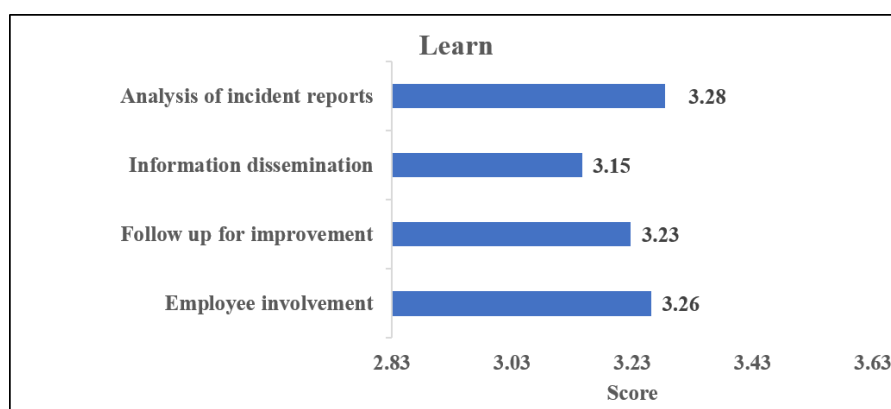


Figure 2 Score of Each Variable for Learn Quality

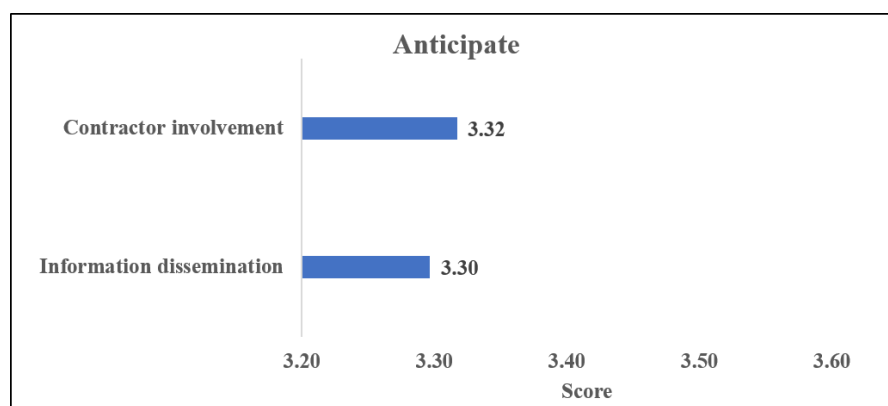


Figure 3 Score of Each Variable for Anticipate Quality

Ability to Anticipate has two indicators consisting of contractor involvement variable with higher score (3.32) compare to information dissemination (3.30) however the difference is small.

Ability to monitor has highest score on HSE performance reward variable (3.45) followed by leading and lagging indicators and HSE inspection with both have value of 3.44. Access to HSE performance statistic has the lowest score (3.07) (Figure 4).

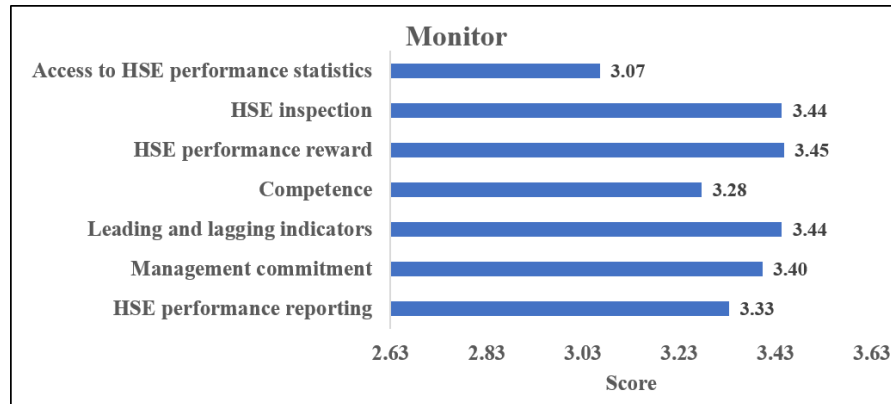


Figure 4 Score of Each Variable for Monitor Quality

Resilience qualities scores in Figure 5 shows that ability to respond has the highest value (3.53) followed with ability to monitor (3.34) and anticipate (3.31) while ability to learn has the lowest one (3.23). All of the variable's scores has exceeded three on a maximum scale of four which based on MMOR it has achieved "resilient" level and moving to higher level of "antifragile".

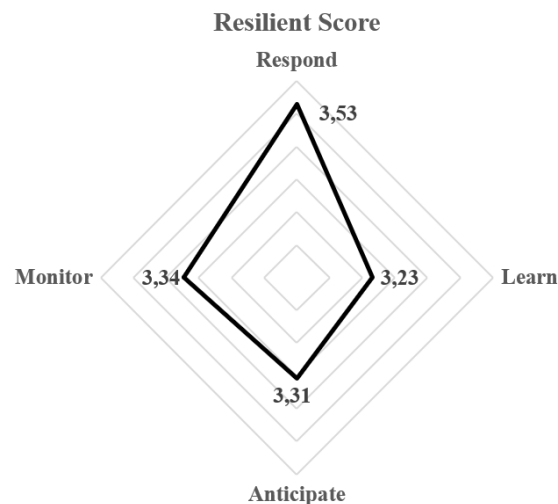


Figure 5 Overall Resilient Qualities Score

Resilience score of all qualities based on employment status (Figure 6) shows that contractor's score is higher compared to permanent employee however mean difference analysis by Wilcoxon-Mann-Whitney Test shows that there is no significant difference of these scores (W value 8485 and p-value 0.0980).

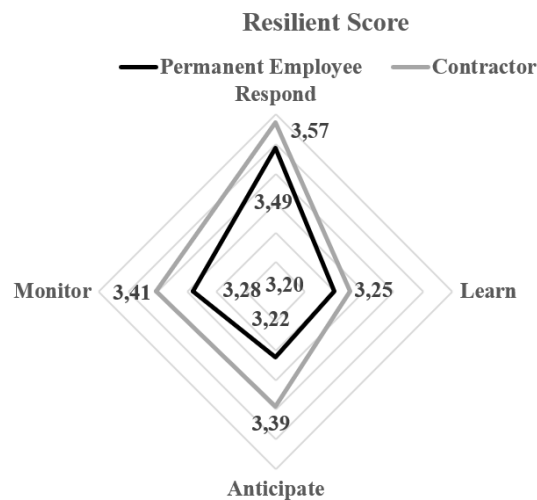


Figure 6 Resilience Qualities Score based on Employment Status

Interview result of 20 personnel representing two companies (one national and one multinational) reveals that oil and gas companies have already implemented safety management system as per requirement of Indonesian Government Regulation on Safety Management System (Government Regulation number 50 year 2012)⁽²⁴⁾ as well as requirement under Ministry of Energy and Mineral Resources decree regarding Guideline for Evaluation of Oil and Gas Safety Management System issued by number 176.K/MG.01/MEM.M/2024, 2024⁽¹⁷⁾. Elements of the safety management system includes requirement to develop risk management, crisis and emergency management, incident investigation as well as monitoring, performance evaluation and audit. These elements are part of ability to anticipate, to respond, to learn and to monitor which indicates that company must perform necessary effort to become resilient organization. Interview results also indicate that the companies have meet the requirements as summarized in Table 9.

Table 9 Summary of Interview Result

Topics	Summary
1. Emergency response tactics and strategies	Companies have developed emergency response plan completed with response tactic and strategies. The plan has been updated in regular basis or if there is input particularly after audit or lesson learnt from exercise and simulation.

Table 9 Summary of Interview Result (Cont.)

Topics	Summary
2. Regular audits of emergency response capability	Internal and external audit have been performed per the requirement of system management both ISO45001 as well as Indonesian oil and gas system management standard. The audit elements include emergency response capability.
3. Identification of potential future threats	Company has HSE risk register which is updated in regular basis. The register contains current as well as future risks of company operation
4. Awareness regarding potential future safety risks in all of Company's activities	There are regular communication and meeting sessions to discuss HSE risk register involving all level to ensure that employees including contractors aware of both current and future HSE risk
5. Anticipating potential incidents in future	Program has been developed as part of HSE risk register action plan to anticipate and manage current and future risk
6. Incident analysis for lesson learnt	Incidents particularly with severe consequences have been investigated however minor incident or near miss not always investigated. Lesson learnt are communicated to all employees including contractor although is not always consistently performed.

However, there are still current and future risks which needs further mitigation. The risk include:

1. difficulties in performing emergency response to production facility located in nearshore swampy area that accessible only during high tide. The existing plan is to access the facility via onshore route in case of low tide; however, the road condition is also limited and not easily accessible by vehicle.
2. Company's personnel have received necessary training and capability development in handling emergency occurred on offshore facilities however it is not conclusive on how to confirm if the competencies are adequate. One of the common methods to confirm the competence is to perform emergency exercise or simulated drill at offshore facility, however this is high risk activity that potentially led to incident; hence it must be conducted with highest caution.

Feedback from respondent indicates that workers realize the importance of safety in carrying their work to prevent incident. They are also willing to get more involved in safety implementation including participation in handling emergency response, incident investigation, providing input on potential future risks and hazards reporting in their daily activities. Highlighted feedback with regard to HSE implementation are outlined in Table 10.

Table 10 Highlighted Feedback

Topic	Summary of Feedbacks
Balance between safety and production	Conflict of priorities between safety and production is still a common issue, in which safety is still perceived as hindering production/operations.
HSE Program	Safety programs are still implemented primarily as administrative requirements, but their actual implementation in the field is not yet optimal.
Competence	Improvement of safety competence for all personnel is required including those related to process safety.
Access to safety reporting	Improvement is needed on accessibility of information technology in hazard reporting and safety performance statistics for all workers including contractors.
Safety resources	Safety resources are still perceived as insufficient to meet organizational needs.
Follow up	Follow up of hazard reporting needs to be monitored and its status are communicated to workers.

The feedback consistent with the questionnaire result particularly on competence, access to reporting and follow up for improvement which all have lower scores than potential for future improvement. Safety and production conflict as well as perception that safety programs are still implemented as administrative requirement are the concern that need further action to balance as it will affect safety resilience in long term.

Discussion

Continuous improvement in performing respond, exercise and simulation along with employee involvement variables within ability to respond is dominating the effort in achieving resilience.

Competence is the variable that need further improvement which is consistent with feedback from respondent. Follow up for improvement within ability to learn has lower score compare to employee involvement and analysis of incident reports which is an opportunity for improvement that consistent with feedback from respondent. Information dissemination has lower score which is also consistent with feedback from employee regarding follow up of hazard reporting and communication of its status to employee. Anticipate has similar scores on both of its variables however compare to variables in respond and monitor qualities, the scores are lower hence it is opportunity for improvement. Score of access to HSE performance statistic is the lowest within ability to monitor which shows that safety information transparency was still an issue in the organization. HSE inspection, HSE performance reward along with lagging and leading indicators have high score which shows that company has performed well in these aspects.

Ability to respond has the highest score compare to the other three qualities. This is consistent with many researches as highlighted by Mufti et al⁽²⁵⁾ that ability to respond has highest score compare to others although there are also fewer studies that shows this ability has lowest score. Study by Tiera et al⁽²⁶⁾ within construction sector also indicates that respond ability has highest score. However other study by Yu et al⁽¹⁴⁾ conducted on oil and gas Floating Production Storage and Offloading (FPSO) Facility, Safi et al⁽²⁷⁾ in hospital setting and Penaloza et al⁽²⁸⁾ in construction sector indicates that respond ability has lowest score compare to the other qualities. Study by Safi showed that monitor ability has the highest score with respond has the lowest one. The respond ability is required to address immediately any factual threat in form of incidents or emergencies which failure to do so will lead to incident escalation and serious consequences⁽¹⁴⁾⁽¹²⁾. Therefore, it is critical ability to secure organization sustainability⁽²⁹⁾ and must be developed at the first opportunity. This ability along with ability to monitor are required to ensure organization can navigate safely in the current or short-term time frame.

However, in long term time frame, these two abilities of respond and monitor are not sufficient for organization to ensure continuation of their operation. Organization needs to learn from the past experiences which will guide what set of responses that they have to perform and what number and type of indicator that they need to monitor. Ability to learn has the lowest score indicating that this ability to secure future of the organization is still need improvement. Anticipate has the score similar to the ability to monitor indicating that anticipation is already part of oil and gas industry focus.

Contractor personnel have higher score compared to permanent employee even though the difference is not statistically significant. However, some researches have shown that this difference is common phenomena. Cox et al⁽³⁰⁾ shows that permanent employees have strongest positive attitudes toward safety compare to contractor personnel therefore they have higher expectation for organization to improve safety implementation. This could occur due to differences in focus and interests between them⁽³¹⁾. Permanent employees consider organizational and group levels as significant referents of their safety perceptions, while temporary employees focus on the individual level. The difference could also occur due to relationship with management and trust ⁽³²⁾ that need time to develop. Contractor personnel usually work for limited time frame compare to permanent employee; therefore, they will have less relationship and trust with company's management.

Interview result show that there are risks that already identified (difficult access to facility during low tide and competence verification of emergency response team), however it is still not fully controlled. Feedback from respondent indicate that conflict of priority between safety and production/operation target is still an issue raised by employee. This conflict is common occurrence in the organizations^(33,34). Safety is still perceived as administrative requirements instead of critical factor in securing safe operation. Some administrative aspects that can hinder safety implementation are overly formalistic safety procedures and complex incident reporting⁽³³⁾. Transparency in safety reporting and safety performance statistic is also still an issue. Access to reporting and statistic is not provided to all employees particularly contractor personnel. Follow up of hazard reporting as well as incident investigation recommendation are also still not effective. Follow up of hazard reporting and incident investigation has not communicated properly to employees as indicated in low score for variable follow up for improvement in ability to learn. These could occur due to resources limitation which is also raised in the feedback. Sufficient resources are one of the keys to the success of implementing safety, otherwise, it can result in ineffective implementation^(34–38). Variables employee and contractor personnel involvement has high score indicating employee eagerness to get involve in safety implementation. They have perception that safety is their individual responsibility, but feedback from questionnaire suggests that in practice the organization still depends heavily on the role of the safety/HSE team.

The study has shown safety resilient qualities of Indonesia oil and gas company along with potential improvement required to sustain it however, the study has limitation since its cross-sectional design using survey and interview which may prone to bias. The companies participated in the study

were also limited and purposely selected since not all companies willing to involve in the study. The mixed method of quantitative and qualitative research ensures that the quantitative result of the questionnaire complimented with qualitative analysis of interview and feedback result will minimize the bias hence improving quality of the study.

Conclusion

Oil and gas company participated in the study has exhibit high scores on all of resilience qualities however it is still focusing more on response and monitor capability which is critical requirement to enable organization to navigate safely within current or short time frame however, for future and long-term time frame they need to improve the other qualities particularly the learning capability. The variables within each qualities show that there are still ones with low scores. There are identified risks which are not controlled yet which requires companies to perform further assessment to identify feasible actions to manage these risks. Conflict between safety and production is still a concern raised by employee which could increase risk in achieving safe operation. Safety should be perceived as critical aspect to support safe operations/production, but due to obstacles such as limited resources, administrative aspects of implementing safety that are quite numerous and high production targets gives rise to the conflict.

All of these facts show that despite good resilience level of oil and gas company in Indonesia, there are low score variables and concerns that company need to consider for improvement since it may affect the whole resilience level if not appropriately managed. Continual improvement on variables with low score particularly on those qualities that enable organization to look for the future such as ability to learn and anticipate are necessary to enable organization sustainability. Balancing safety and production as well as increasing necessary resources will also help in boost the resilience. Future longitudinal study which involves more respondent and companies can be performed to reveal resilience level variation and its persistent challenges over extended period.

Ethical Approval Statement

This study has received ethical approval from the Research Ethics Commission, Faculty of Public Health, Universitas Indonesia with Ethical Review Number Ket-499/UN2.F10.D11/PPM.00.02/2024, dated 12 June 2024.

Author Contributions

N and M contributed to the design and implementation of the research as well as involved in the data analysis, while ZD provided supervision. N and M were involved in manuscript preparation, content refinement, and administration while ZD provided review and content refinement of the manuscript. All the authors discussed the results and contributed to the final manuscript

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