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EFFECTIVENESS OF BASIC HSSE TRAINING IN IMPROVING WORKERS' KNOWLEDGE IN AN UPSTREAM OIL AND GAS COMPANY

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Abstract

The oil and gas industry is a sector with a very high risk of occupational accidents due to its operational characteristics, which involve hazardous environments and unsafe worker behavior. Although Basic HSSE Training has become a mandatory standard in the oil and gas industry, evaluating its effectiveness remains urgent to ensure that the training is not merely a formality for regulatory compliance, but is truly aligned with the specific operational risks, work environment, and safety culture of Company. This study uniquely combines a pretest–posttest evaluation of Basic HSSE Training with an analysis of key organizational factors using multivariate statistical methods to identify dominant drivers of knowledge improvement among upstream oil and gas workers. This study aims to evaluate the effectiveness of Basic HSSE Training by measuring differences in workers' knowledge levels before (pre-test) and after (post-test) the training, as well as examining the influence of organizational factors management commitment, safety policies, regulations and procedures, HSSE communication, work environment, and worker involvement on knowledge improvement. A quantitative approach with a pretest–posttest design was employed, involving 303 workers at Company X in the upstream oil and gas sector in South Sumatra Province. Data were collected using Likert-scale questionnaires and multiple-choice tests. The Paired Samples t-test results indicate that Basic HSSE Training is effective in improving workers' knowledge, while Chi-Square and logistic regression analyzes show that organizational factors, particularly communication and work environment, play a dominant role in influencing the effectiveness of the training.

Keywords: Basic; Evaluation; HSSE; Training.

INTRODUCTION

The oil and gas industry is a sector with an exceptionally high risk of occupational accidents due to operational characteristics involving flammable materials, high-pressure systems, working at heights, heavy equipment operation, and exposure to hazardous chemicals. Data from BPJS Employment in 2023 indicates that the mining and energy sectors are among the top five industries with the highest number of workplace accidents, recording more than 5,000 incidents throughout the year. The main causes of accidents in the construction industry include unsafe practices, unsafe conditions, and management problems (1).

Occupational Safety and Health (K3) is a fundamental aspect in maintaining the continuity of work activities and protecting the workforce, both in the industrial sector and the service and government sectors (2). Occupational safety and health (K3) is a crucial aspect in the industrial environment (3) . Work-related accidents in the oil and

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gas industry are largely influenced by Andrea, Handayani et al. (2023) a combination of hazardous environmental factors and unsafe worker behavior. That unsafe actions have an odds ratio (OR) of 24.43, while unsafe conditions have an OR of 11.26 as risk-enhancing factors for accidents (4) . Studies also confirm a significant relationship between unsafe conditions and accident occurrences in the energy sector. These findings provide strong evidence that controlling physical environmental risks and fostering safe behavior must be implemented simultaneously within safety management (5).

The mandatory implementation of occupational safety in the oil and gas industry is regulated through national and international frameworks. Ministerial Regulation of the Ministry of Energy and Mineral Resources (Permen ESDM) No. 38 of 2017 requires the implementation of an Occupational Health and Safety Management System (SMK3), which includes hazard identification, risk control, inspections, audits, and routine safety training. ISO 45001:2018 further outlines safety competency standards that workers must possess based on operational risk levels. These regulations emphasize that safety training holds a strategic position as an operational prerequisite within oil and gas companies (6) . HSSE training is designed to enhance workers' competence in understanding hazards, performing emergency procedures, using personal protective equipment (PPE) correctly, and applying standard operating procedures (SOPs) with discipline. Although numerous studies have examined the effectiveness of HSSE training in the oil and gas sector, most existing research primarily focuses on general outcomes such as knowledge improvement or accident reduction rates. Limited attention has been given to the internal mechanisms through which Basic HSSE training influences multiple dimensions of safety competence simultaneously, including SOP compliance, PPE usage, emergency preparedness, and the internalization of safe work behaviors within specific operational contexts. Moreover, empirical evidence that integrates organizational variables and evaluates training effectiveness within the Indonesian oil and gas industry remains relatively scarce. This gap indicates the need for a more comprehensive and context-sensitive

evaluation of Basic HSSE training effectiveness. Furthermore, the effectiveness of HSSE training remains a critical issue, particularly due to the gap between training content and actual field practices, as identified by (6) This condition underscores the importance of evaluating not only the outcomes of training but also its relevance, content, instructional methods, and delivery processes in relation to real operational risks.

The quality of training is determined by several components, including appropriate planning, risk-based material selection, understandable learning methods, instructor competence, and adequate supporting facilities. Weaknesses in any of these elements may reduce the training's ability to enhance workers' knowledge and safety awareness. Given the inherently high-risk nature of oil and gas operations, HSSE training must be capable of developing safety competencies that are deeply internalized and consistently applied by workers. Occupational Health and Safety (K3) should be implemented as an effort to anticipate workplace accidents and the transmission of occupational diseases by identifying factors that have the potential to cause accidents and diseases (hones) due to work and the activities expected in the work environment. If work-related accidents and illnesses occur, these can be minimized as much as possible (7).

Organizational variables such as management commitment, safety policies, regulations and procedures, HSSE communication, work environment, and worker involvement play a crucial role in supporting training effectiveness. Management commitment ensures the allocation of resources and strategic direction for safety programs. Clear policies and procedures improve consistency in OSH implementation. Effective HSSE communication enhances worker compliance with SOPs. A safe work environment promotes safe work behaviors, while active worker involvement in OSH activities strengthens organizational safety culture (10).

Occupational Health and Safety activities to increase and improve employee productivity can be carried out through safety promotion or promoting an OHS culture in the workplace. These activities include training, visual management in each work area (safety

boards, safety signs, posters, banners, slogans), safety meetings (Occupational Safety and Health Advisory Committee/P2K3 meetings, safety briefings), organizational awards, and drills (emergency response simulations) that convey informative, persuasive, and emotional messages (11) . These six organizational factors are therefore hypothesized to significantly influence the effectiveness of Basic HSSE training.

Globally, workplace incidents in the oil and gas industry frequently occur due to inadequate safety competence and non-compliance with regulations. (12) highlights that training programs misaligned with actual operational risks increase the likelihood of severe incidents such as fires and explosions. Additionally, the rapid evolution of the oil and gas industry—marked by the integration of automation, IoT sensors, and digital monitoring systems requires HSSE training to continuously adapt to emerging technology-based risks. emphasize that continuous competency development is essential to ensure workers' readiness in managing evolving hazards.

Measuring training effectiveness requires an approach capable of objectively capturing changes in worker competence. The pre-test and post-test design allows for systematic comparison of knowledge levels before and after training participation. Recommend this approach as an effective method for evaluating improvements in HSSE knowledge and competencies (13).

Based on these considerations, this study addresses existing knowledge gaps by examining the effectiveness of Basic HSSE training through an integrated assessment of organizational factors and measurable changes in worker competence using a pre-test and post-test design. By focusing on the Indonesian oil and gas context, this research is expected to contribute a more comprehensive and context-specific understanding of how Basic HSSE training influences safety knowledge, behavior, and organizational safety performance, thereby providing strategic recommendations for enhancing HSSE implementation in the oil and gas industry.

RESEARCH METHODS

This study employed a quantitative approach using a pretest–posttest design. The research sample of 303 workers. Data were collected through questionnaires

using both Likert scales and multiple-choice items. The data analysis techniques included univariate tests, normality tests, paired sample t-tests, chi-square tests, and linear logistic regression.

RESULTS AND DISCUSSION

Results

We acknowledge the potential influence of confounding factors such as length of service, type of work (operational vs. non-operational), and level of education. These variables were recorded as part of respondent characteristics and considered during data analysis to ensure that changes in knowledge scores were not disproportionately influenced by specific background factors. The improvement in pretest–posttest scores was observed across different respondent categories, indicating a consistent training effect.

Table 1. Differences in HSSE Knowledge Scores Before (Pretest) and After Training (Posttest)

		Paired Differences				t	df	Sig. (2-tailed)
		Mean	Standard Deviation	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1	Pretest - posttest	-37,294	13,743	-38,847	-35,740	-47,235	302	.000

Source: Data Processing , 2025

The results of the Paired Samples t-Test indicated a significance value of 0.000, which is lower than 0.005, demonstrating a statistically significant difference between knowledge scores before the training (pretest) and after the training (posttest). The increase in posttest scores confirms that the Basic HSSE training was effective in enhancing workers' knowledge and understanding of safety, health, security, and environmental aspects in the workplace. Statistically, this finding reflects a successful learning process, in which participants were able to absorb the training materials optimally and internalize the information delivered. Theoretically, these results are consistent with the principles of adult learning theory (andragogy). Which emphasizes that adult learners' comprehension improves when training content is directly relevant to their work, delivered in an applicative manner, and allows learning through experience. HSSE training commonly adopts an experiential learning approach, is effective in deepening conceptual understanding and improving knowledge retention because participants are not only receiving

theoretical input but also relate it to real work situations. In the context of the high-risk oil and gas industry, training designs that incorporate simulations, case studies, and problem-solving exercises strongly support deeper post-training comprehension. From the perspective of safety behavior change, this finding can be explained through the Safety Knowledge Safety Compliance concept, as reinforced which posits that increased knowledge is a critical initial step toward improving safety compliance and safe work behavior.

Therefore, the improvement in posttest scores not only reflects successful learning outcomes but also serves as a foundation for long-term behavioral change in the application of safe work practices. These findings are consistent with several studies conducted within the past five years. The effectiveness of Basic HSSE training can also be logically explained by several assumptions, including the high relevance of training materials to actual work conditions, the high competence of instructors in the oil and gas sector, the presence of a strong organizational safety culture that enhances learning motivation, and the regular and structured implementation of training programs.

These measures reduce the likelihood that the observed score increases were driven by familiarity with the test items and support the interpretation that the improvements reflect genuine learning outcomes from the Basic HSSE training. Overall, the findings of this study underscore the important role of Basic HSSE training in preparing workers to perform their duties safely and highlight the necessity of continuous training as a core pillar of workplace safety in the oil and gas industry, where strong knowledge forms the foundation for the development of positive safety attitudes and behaviors.

Table 2. The Influence of Management Commitment on Basic HSSE Training

Management Commitment	Basic HSSE Training				Total	%	*p-value*	OR
	Less adequate		Adequate					
	f	%	f	%				
Less Adequate	14	35	26	65	40	100	0.008	2,833
Adequate	42	16	221	84	263	100		
Total	56		247		303			

Source: Data Processing, 2025

The study found that of 263 respondents, 221 (84%) working under strong management commitment achieved Basic HSSE training outcomes in the

"adequate" category, while 42 respondents (16%) were classified as "less adequate." These categories were determined based on percentage scores of the assessment instrument, with ≥75% classified as adequate and <75% as less adequate, referring to national and international HSSE standards, including Indonesia's SMK3 (Government Regulation No. 50/2012) and ISO 45001:2018. The Chi-Square test yielded an Asymp . Sig value of 0.008 (<0.05), indicating a significant association between management commitment and Basic HSSE training outcomes among workers at Company X in the upstream oil and gas sector of South Sumatra Province. An odds ratio of 2.83 indicates that workers exposed to strong management commitment were nearly three times more likely to achieve adequate HSSE training outcomes than those in environments with weaker commitment. These findings support safety management and High Reliability Organization theories, which emphasize management commitment and safety culture as critical determinants of training effectiveness.

Table 3. The Influence of Safety Policies on Basic HSSE Training

Safety Policies	Basic HSSE Training				Total	%	*p-value*	OR
	Less adequate		Adequate					
	f	%	f	%				
Less Adequate	25	43.1	33	56.9	58	100	0.000	5.23
Adequate	31	12.7	214	87.3	245	100		
Total	56		247		303			

Source: Data Processing, 2025

The study findings indicate that among 245 respondents who had positive perceptions of the company's safety policy, only 31 respondents (12.7%) obtained Basic HSSE training outcomes in the "less adequate" category. In contrast, the majority of 214 respondents (87.3%) achieved outcomes in the "adequate" category. The Chi-Square analysis produced an Asymp. Sig value of 0.000, which is lower than 0.05, indicating a significant relationship between safety policy and the effectiveness of Basic HSSE training among workers at Company X in the upstream oil and gas sector of South Sumatra Province. The odds ratio value of 5.23 further suggests that workers with positive perceptions of the safety policy were 5.23 times more likely to achieve better training outcomes

compared to those with poorer perceptions. The odds ratio value of 5.23 in this study demonstrates that safety policies function not merely as formal documents but as contextual factors shaping workers' readiness to learn. The underlying assumption is that workers who understand and accept safety policies tend to be more compliant, possess higher safety awareness, and show greater openness to the learning process during HSSE training.

Table 4. The Influence of Good Communication on Basic HSSE Training

Good Communication	Basic HSSE Training				Total	%	*p-value*	OR
	Less adequate		Adequate					
	f	%	f	%				
Less Adequate	25	43.1	33	56.9	58	100	0.000	39,032
Adequate	31	12.7	214	87.3	245	100		
Total	56		247		303			

Source: Data Processing, 2025

The study found that among 273 respondents with good communication quality, 242 respondents (88.6%) achieved Basic HSSE training outcomes in the "adequate" category, while only 31 respondents (11.4%) were classified as "less adequate." The Chi-Square test yielded an Asymp . Sig value of 0.000 (< 0.05), indicating a statistically significant association between communication quality and the effectiveness of Basic HSSE training among workers at Company X in the upstream oil and gas sector of South Sumatra Province. The odds ratio of 39.0 indicates that workers with good communication were substantially more likely to achieve adequate training outcomes than those with poorer communication.

Table 5. The Influence of OHS Regulations and Procedures and Basic HSSE Training

OHS Regulations and Procedures	Basic HSSE Training				Total	%	*p-value*	OR
	Less adequate		Adequate					
	f	%	f	%				
Less Adequate	20	80	5	20	25	100	0.000	26.89
Adequate	36	12.9	242	87.1	278	100		
Total	56		247		303			

Source: Data Processing, 2025

Of the 278 respondents who reported positive perceptions of OHS regulations and procedures, only 36 respondents (12.9%) had less adequate Basic HSSE training outcomes, while the remaining 242 respondents (87.1%) achieved

adequate Basic HSSE training outcomes. The analysis using the Chi-square test yielded an Asymp. Sig. value of 0.000. Since the Asymp. Sig. value was less than 0.05, it can be concluded that there is a statistically significant relationship between OHS regulations and procedures and Basic HSSE training outcomes among workers of PT.

The odds ratio was 26.89, indicating that respondents with positive perceptions of OHS regulations and procedures were 26.89 times more likely to have adequate Basic HSSE training outcomes compared to respondents with poor perceptions of OHS regulations and procedures.

Table 6. The Influence of the Work Environment on Basic HSSE Training

The work environment	Basic HSSE Training				Total	%	*p-value*	OR
	Less adequate		Adequate					
	f	%	f	%				
Less Adequate	20	50	20	50	40	100	0.000	6,306
Adequate	36	13.7	227	86.3	263	100		
Total	56		247		303			

Source: Data Processing, 2025

The results showed that among 263 respondents who assessed their work environment as good, only 36 respondents (13.7%) obtained Basic HSSE training outcomes categorized as poor, while the remaining 227 respondents (86.3%) achieved outcomes in the adequate category. The Chi-Square analysis produced an Asymp. Sig value of 0.008, which is smaller than 0.05, indicating a significant relationship between the work environment and the effectiveness of Basic HSSE training among workers at Company X, Upstream Oil and Gas, South Sumatra Province. The odds ratio of 6.3 indicates that respondents who perceived their work environment as good were 6.3 times more likely to achieve satisfactory training outcomes compared to those who perceived their environment as poor. When the workplace encourages open communication, collaboration, and safe work practices, workers can more easily reflect on, internalize, and apply the knowledge gained.

Table 7. The Influence of Worker Involvement in OHS Activities on Basic HSSE Training

Worker involvement in OHS activities	Basic HSSE Training				Total	%	*p-value*	OR
	Less adequate		Adequate					
	f	%	f	%				
Less Adequate	18	35.3	33	64.7	51	100	0.000	3,702
Adequate	38	15.1	214	84.9	252	100		
Total	56		247		303			

Source: Data Processing, 2025

The study findings indicate that among 252 respondents with a high level of involvement in OHS activities, only 38 respondents (15.1%) obtained Basic HSSE training outcomes in the poor category, while the remaining 214 respondents (84.9%) achieved outcomes in the adequate category. The Chi-Square test produced an Asymp. Sig value of 0.001, which is smaller than 0.05, indicating a statistically significant relationship between worker involvement and the effectiveness of Basic HSSE training at Company X, Upstream Oil and Gas, South Sumatra Province. This is further supported by an odds ratio of 3.07, showing that workers with high involvement levels are more than three times more likely to achieve good training outcomes compared to those with low involvement.

Table 8. The Influence of the Work Environment on Basic HSSE Training

No	Variables	B	Sig	Exp (B)	95% (CI)
1	Policy	1,206	.006	3,341	1,410-7,916
2	Regulation	2,278	.001	9,754	2,403 – 39,589
3	Communication	2,334	.000	10,320	2,933 – 36,312
4	Environment	1,659	.000	5,256	2,156 – 12,813
5	Involvement	1,019	.032	2,772	1,091 – 7,041

Source: Data Processing, 2025

Further analysis revealed that among all variables examined, communication (X3) and work environment (X5) were the most dominant factors influencing the effectiveness of Basic HSSE training among workers. The communication variable showed a significant value of p = 0.000 with an Exp(B) or odds ratio of 10.320. This indicates that workers with good communication skills have approximately 10.3 times higher likelihood of achieving good Basic HSSE training outcomes compared to those with poorer communication abilities. Meanwhile, the work environment variable was also statistically significant, with p = 0.000 and

an odds ratio of 5.256, meaning that workers who perceive their work environment as conducive have 5.256 times higher chances of achieving good HSSE training results than those who perceive their environment as less supportive.

Discussion

Differences in HSSE Knowledge Scores Before (Pretest) and After Training (Posttest) / Level of Effectiveness of the Basic HSSE Training for Workers at Company X, Upstream Oil and Gas Sector, South Sumatra Province

The increase in posttest scores confirms that the Basic HSSE training was effective in enhancing workers' knowledge and understanding of safety, health, security, and environmental aspects in the workplace. Statistically, this finding reflects a successful learning process, in which participants were able to absorb the training materials optimally and internalize the information delivered. Theoretically, these results are consistent with the principles of adult learning theory (andragogy). Which emphasizes that adult learners' comprehension improves and allows learning through experience. HSSE training commonly adopts an experiential learning approach, is effective in deepening conceptual understanding and improving knowledge retention because participants not only receive theoretical input but also relate it to real work situations. Safety Knowledge Safety Compliance concept, as reinforced, which posits that increased knowledge is a critical initial step toward improving safety compliance and safe work behavior.

The Influence of Management Commitment on Basic HSSE Training Among Workers at Company X, Upstream Oil and Gas Sector, South Sumatra Province

The Chi-Square test yielded an Asymp. Sig value of 0.008 (<0.05), indicating a significant association between management commitment and Basic HSSE training outcomes among workers at Company X in the upstream oil and gas sector of South Sumatra Province. An odds ratio of 2.83 indicates that workers exposed to strong management commitment were nearly three times more likely to achieve adequate HSSE training outcomes than those in environments with weaker commitment. The Influence of Management Commitment on Basic HSSE Training Among Workers at Company X, Upstream Oil and Gas Sector, South Sumatra Province.

The Good Communication on Basic HSSE Training Among Workers at Company X in the Upstream Oil and Gas Sector of South Sumatra Province

Given the unusually high odds ratio, additional checks were conducted to minimize the risk of sparse data bias or overestimation. Cell frequency distributions were examined and confirmed to meet the minimum expected count assumptions for the Chi-Square test, indicating that the estimate was not driven by sparse data. Furthermore, the distribution of responses showed a consistent and strong pattern across categories, supporting the robustness of the effect size. Thus, the high odds ratio reflects a genuinely strong association rather than a statistical artifact.

In HSSE training, high-quality communication facilitates active participation, accurate interpretation of procedures, and effective interaction between trainers and participants, which are essential for mastering technical safety competencies (14) . Empirical studies further support this interpretation. Recent research in high-risk industries has demonstrated that effective communication significantly improves understanding, retention, and application of safety training materials. Therefore, the magnitude of the odds ratio in this study suggests that communication is not merely a supporting factor but a key determinant of Basic HSSE training effectiveness.

The Influence of Occupational Health and Safety (OHS) Regulations and Procedures and Basic HSSE Training among Workers of PT

The odds ratio was 26.89, indicating that respondents with positive perceptions of OHS regulations and procedures were 26.89 times more likely to have adequate Basic HSSE training outcomes compared to respondents with poor perceptions of OHS regulations and procedures.

The Influence of the Work Environment on Basic HSSE Training Among Workers at Company X, Upstream Oil and Gas, South Sumatra Province

Theoretically, this relationship aligns with the views of modern occupational safety experts. That a conducive work environment including coworker support, responsive leadership, and safe physical conditions can enhance learning motivation and worker engagement in safety training. A positive environment creates a psychological climate that enables workers to participate actively in training because they feel safe, valued, and

supported. Furthermore, that a good work environment influences learning readiness and workers' capacity to absorb occupational health and safety training materials.

In the context of HSSE training, (15) states that training effectiveness is not determined solely by the design of the training itself but is also strongly influenced by the work environment during and after the training. When the workplace encourages open communication, collaboration, and safe work practices, workers can more easily reflect on, internalize, and apply the knowledge gained from training.

The Influence of Worker Involvement in OHS Activities on Basic HSSE Training Among Workers at Company X, Upstream Oil and Gas, South Sumatra Province

This study also aligns with several empirical findings in the last five years. That worker involvement significantly influences the effectiveness of safety training in the mining industry.

Overall, the study confirms that worker involvement is a key determinant of the success of Basic HSSE training programs. Therefore, companies must strengthen a work culture that promotes participation, two-way communication, and recognition of worker contributions too continuously enhance the effectiveness of safety training.

The Most Dominant Factors Influencing the Effectiveness of Basic HSSE Training Among Workers at Company X, Upstream Oil and Gas, South Sumatra Province

Theoretically, the strong influence of communication on training effectiveness aligns. who argues that communication serves as the primary foundation for conveying information, understanding instructions, and facilitating workplace learning. In the context of safety training, effective communication enables workers to clearly understand work risks, safety procedures, and training instructions. The work environment, which was also found to be a significant factor, has a strong theoretical basis.

Overall, the findings suggest that to maximize the effectiveness of Basic HSSE training, companies need to prioritize improving the quality of internal communication as well as ensuring the implementation of a safe, supportive, and conducive work environment. These two factors have been proven to be the key components in determining the success of safety training in the oil and gas industry.

CONCLUSION AND RECOMMENDATION

This study concludes that Basic HSSE Training is proven to be effective in significantly improving workers' knowledge in the upstream oil and gas sector, as evidenced by the substantial differences between pretest and posttest scores. In addition, organizational factors—namely management commitment, safety policies, OHS regulations and procedures, communication, work environment, and worker involvement were found to have a significant influence on training effectiveness, with communication and work environment emerging as the most dominant factors. These findings indicate that HSSE training effectiveness is not solely determined by training content and delivery, but is strongly shaped by organizational support and the surrounding work climate. Therefore, it is recommended that companies continuously improve the quality and relevance of Basic HSSE Training through periodic evaluations, strengthen internal communication systems, and create a safe, supportive, and participatory work environment. Management should consistently demonstrate commitment to HSSE implementation, ensure clear and enforceable safety policies and procedures, and actively involve workers in OHS activities so that the knowledge gained from training can be internalized and translated into sustainable safe work behaviors.

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