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Teaching-based Safety Training: Effects on Safety Performance in Niger Delta Oil and Gas Firms

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to determine the impact of teaching-style safety training on safety performance in selected oil and gas companies in Niger Delta, Nigeria. Safety performance was operationalized using safety compliance, safety participation and accident occurrence. The study adopted inferential research design. Multi-stage sampling technique was used to sample few companies from the population while Taro Yamane sample size formula was used to estimate 400 as sample size. Structured questionnaire, designed based on five-point Likert scale, was used for data collection. Regression and structural equation model were used for the data analyses. The

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results of regression and structural equation analyses revealed that teaching-based safety training has positive and significant impact on safety compliance (β = 0.263 p-value = 0.000 < 0.05) but positive and insignificant impact on safety participation and accident occurrence (β = 0.054 p-value = 0.534 > 0.05, β = 0.074 p-value = 0.371> 0.05, respectively). The results also revealed that only safety compliance has complete mediating effect in relationship between teaching-based safety training and accident occurrence. It was concluded that teaching-based safety training has partial impact on leading safety performance (safety compliance) but no significant impact on lagging safety performance (accident occurrence) and recommended that management of oil and gas firms should utilize complete safety training package for their workers to ensure sustainable level of safety performance.

Keywords: Teaching-style safety training; safety performance; safety compliance; safety participation; accidents occurrence; Niger Delta.

1. INTRODUCTION

In Nigeria, the oil and gas industry is a major contributor to the economy; as a result, there is a pressing need to reduce the number of deaths caused by accidents and enhance the level of safety performance in the country. Accidents can occur in the oil and gas industry because of the interplay of several elements, including environmental, technical, organizational, management considerations, as well as human errors. Standard operating procedures, safety training, and education are all available in oil and gas industry, but there are gaps in its implementation. It is common to discover that certain workers in oil and gas companies are devoted to safety improvement initiatives, while others, in same company, only give lip service to the idea that they are doing so.

According to several research studies on the impact of training on safety performance, many incidents that occur in oil and gas companies may have been as a result of poor or inadequate training. Other factors may have been due to non-adherence of workers to work procedures and non-implementation of safety measures that were gained from various training (Kaminski, 2001; Kinn et al., 2000; Zierold & Anderson, 2006). Many studies have also demonstrated that the presence of safety training methods is inversely connected to the number of accidents and injuries that occur on construction sites (Dong et al., 2004, Dong, 2007, Kaminski, 2001, Kinn et al., 2000, Zierold & Anderson, 2006) Recent studies have addressed the application of advancements in training methodologies in industrial safety, (Bęś & Strzałkowski, 2024) and studies on the integration of technology in safety training (Sarkar, 2021). Thus, the effectiveness of safety training methods in oil and gas firms might be one of the best approaches to improve the overall safety performance. In a study that was conducted by (Pingsday et al., 2008) the researchers identified safety training procedures at construction sites as being essential to enhancing safety performance. In addition, safety training is necessary, particularly for the purpose of educating workers on proper compliance and safety practices. It should provide preventive controls, as well as safeguard against accidents, (Cooper, 2000). It is the responsibility of oil and gas companies in the Niger Delta to ensure the well-being of their employees, prepare them for any potential hazards and instruct them on how to avoid any harm. This can be accomplished through the provision of detailed and substantial teaching-style safety training on specific safety performance indicators, which are evaluated in selected oil and gas companies. Some examples of these indicators include lost time injuries (LTI), lost time accidents (LTA), and near misses.

The findings of research on safety in the oil and gas industries as well as the construction industry continue to point to an alarming knowledge gap in safety and, as a result, poor safety performance among workers. For instance, (Atkinson & Duff, 2005) discovered that low safety awareness are related to more than 70 percent of the injuries that occurred on the work site. Additionally, it has been estimated that only 10 –15 percent of safety training are of practical advantages (Baldwin & Ford, 1988; Cornell & Koll, 2004). It has been observed that many injury investigations recommend additional safety training to prevent injury recurrence (NIOSH, 2015). However, very few other studies have focused on understanding why training efforts fail in the oil and gas industry. For instance, (Goldenhar et al., 2001) explained that certain characteristics of the industry, such as the transient nature of the workforce and the temporal basis of the project, discourage

employers in taking certain decisions. The discouragement includes adopting comprehensive, more expensive, and resourceful safety training, which may affect safety performance. Some typical challenges to successful safety training that might enhance safety performance include time limits and disputes within the project, language difficulties among workers, and the difficulty of measuring and conveying the advantages of training (Ward, 2008).

Aside from the obstacles faced by the industry, the failure of safety training efforts to transfer into improved safety performance can be attributed to a wide range of factors, including inefficient teaching techniques, incompetent teachers, and inadequate training materials. Wilkin (2011) suggests that the typical classroom-style of training be replaced with andragogical approach to increase safety training. These types of training are more successful in engaging adult learners. Mubashar et al., (2013) argued that employing safety training methods that are interesting to employees and that promote conversation, feedback, and action can result in good safety performance among workers. Thus, this current study was directed towards assessing the impact of teaching-based safety training on the safety performance of selected oil and gas companies in the Niger-delta. The key objectives are to ascertain the impact of teaching-style safety training on the leading and lagging safety performance of the selected oil and gas companies in the Niger-delta. Evaluate the mediating effect of leading safety performance and the relationship between teaching-style safety training and lagging safety performance. In this study, safety performance was operationalized using leading indicators (safety compliance and safety participation) and lagging indicator (accidents occurrence).

2. METHODOLOGY

2.1 Research Design

The study adopted inferential study design to evaluate the impact of teaching-style safety training on safety performance in selected oil and gas companies in the Niger Delta. This methodology is chosen because it is proven by other literature reviewed in the area of study (Bates & Homklin, 2013). Also, the research design has been proven successful and effective in similar studies across many industries (Cooper, 1998). Inferential design was adopted to ascertain the impact of teaching-style safety training factors on both leading and lagging safety performance based on correlation, regression and path model statistics.

2.2 Study Area

The Niger Delta Region is situated in the southern part of Nigeria, bordering the Atlantic Ocean (Fig. 1). It is home to about 30 million people. It houses oil wells and operational locations of most oil and gas companies in Nigeria. The core states are Rivers, Bayelsa,

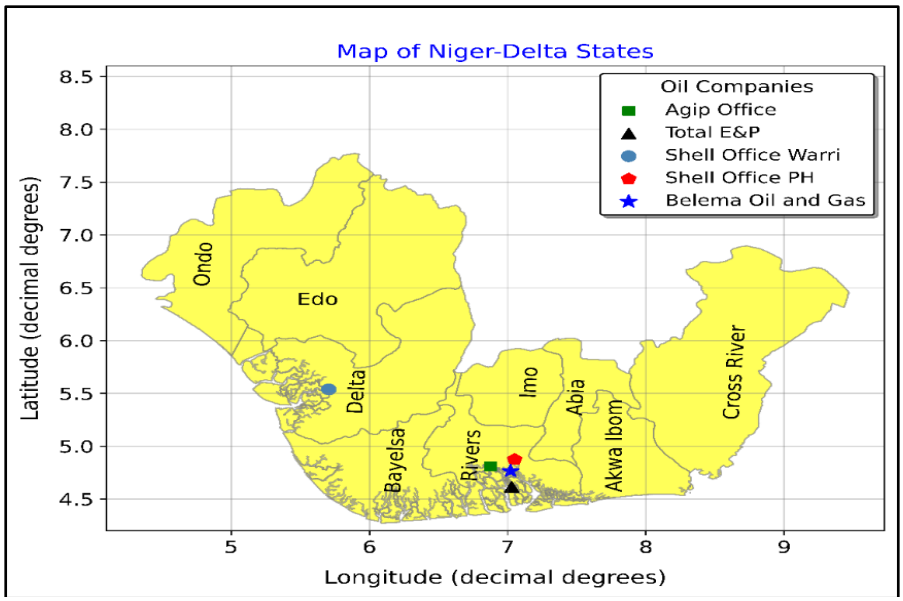

Fig. 1. Map of Study Area

where most of our work is focused with some activities in surrounding states of Akwa Ibom, Cross River, and Delta. The Niger Delta is biodiverse with mangrove providing carbon sequestration capacity and supporting a wide variety of plant and animal life; including agriculture and fishing on which many in the region rely for their livelihood. It sits on top of major hydrocarbon reserves. The Niger Delta region depends solely on latitude, continental position, altitude and the local regional topography.

2.3 Population of the Study

This study is concerned with investigating the impact of safety training on safety performance of the oil and gas firms in Niger-delta states of Nigeria. Therefore, the population of this study comprise of workers of the sampled oil and gas companies situated within the Niger-delta states of Nigeria. The population of the workers in the sampled companies totaled at two thousand three hundred and thirty-seven (2337) according to human resource department data of the oil and gas companies sampled for this study.

2.4 Sample and Sampling Technique

Because of the structure of this study, multi-stage sampling technique was used to sample five oil and gas firms operating in the Niger-Delta.

2.5 Sample Size Determination

Taro Yamane sample size determination formula was used, Equation (1):

$$n = \frac{N}{(1+N)(\varepsilon)^2)} \qquad (1)$$

Where n = Sample size, N = Population under study (1530) and ε = Margin error (which is conventionally be 0.05 at 5% level of significance respectively).

$$n = \frac{2337}{(1+2337)(0.05)^2)}$$

Hence, the sample size for this study is 400

2.6 Methods and Instrument for Data Collection and Analysis

The study adopted quantitative data collection method, with the use of questionnaire to gather data needed for evaluating the impact of training in the selected companies. It employed questionnaire administration for this assessment which covered questions on teaching-style safety training, leading and lagging safety performance. Leading indicator was captured using safety compliance and safety participation while lagging was done using accident occurrence to support the researcher in data collection as well as questions on demographic data of the workers. The questionnaire was explained to the respondents by the research assistants before completion of the questionnaires. The questionnaires used in this research was titled "Safety Training and Safety Performance of Oil and Gas Firms". The questionnaire was designed based on Five-point Likert Scale of Strongly Agree (SA), Agreed (A), Disagree (D), Strongly Disagree (SD) and Undecided (UN) with weighted valued of 5, 4, 3, 2 and 1 respectively. The data collected in the study were analyzed using regression and structural equation model. XL-STAT version 20.1 was used for the descriptive statistics while the regression analysis was carried out using Structural Equation Model (SEM) of the IBM-AMOS.

3. RESULTS AND DISCUSSION

3.1 Regression Analysis

3.1.1 Regression model for the impact of teaching-based safety training on safety participation

Table 1 shows the results of regression analysis carried out to ascertain the impact of teaching-based safety training on safety behaviour operationalized with safety participation. The results revealed that teaching-based safety training has positive but insignificant impact on safety participation at p-value of 0.371 > 0.05 significance level, such that 1 unit change in teaching-based safety training would result to 0.074 corresponding change in safety participation of the workers. The results aligned with finding of the studies carried out by Kaminski (2001), Kinn et al. (2000) and Zierold & Anderson (2006) who revealed that safety training has positive impact on safety behavior of workers in mining, textile and manufacturing industries, respectively. However, while Kaminski (2001), reported that the impact of safety training on safety behavior is significant Kinn et al. (2000) and Zierold & Anderson (2006) reported that the impact is not significant.

Overall, the R^2 value of 0.03 implied that teaching-based safety training contributed to 3% change in safety participation while 97% were contributed by other factors and constructs not considered in the model. Thus, the model that expresses the relationship between safety participation and independent variables, teaching-based safety training is presented in Equation (2):

$$SP = 0.074TST + 3.438 \quad (2)$$

3.1.2 Regression model for the impact of teaching-style safety training on safety compliance

Table 2 shows the results of regression analysis carried out to ascertain the impact of teaching-based safety training and safety behaviour operationalized with safety compliance. The results revealed that teaching-based safety training has positive and significant impact on safety compliance at p-value of 0.000 < 0.05 significance level, such that 1 unit change in teaching-based safety training would result to 0.263 corresponding change in safety compliance of the workers. The results also agreed with the finding of the studies carried out by (Kaminski, 2001; Kinn et al., 2000; Zierold & Anderson, 2006) who revealed that safety training has positive impact on safety behavior of workers in mining, textile and manufacturing industries, respectively. However, while Kaminski (2001) reported that the impact of safety training on safety behavior is significant (Kinn et al., 2000; Zierold & Anderson, 2006) reported that the impact is not significant.

In all, the R^2 value of 0.098 implied that teaching-based safety training contributed to 9.8% change in safety compliance while 90.20% were contributed by other factors and constructs not considered in the model. Thus, the model that expresses the relationship between safety compliance and independent variables; teaching-based safety training is presented in Equation (3):

$$SC = 0.263TST + 4.356 \quad (3)$$

3.1.3 Regression model for the impact of teaching-style safety training on accident occurrence

Table 3 shows the results of regression analysis carried out to ascertain the impact of teaching-based safety training and lagging safety performance (accidents occurrence). The results revealed that teaching-based safety training has positive but insignificant impact on lagging safety performance at p-value of 0.534 > 0.05 significance level, such that 1 unit change in teaching-based safety training would result to 0.057 corresponding change in lagging safety performance of the companies. The finding of this study aligned with the outcome of studies carried out by Atkinson and Duff, 2005, and Pingsday et al., (2008) who in separate studies carried out in construction, oil and gas and mining firms revealed that safety training reduces accident occurrence which translate to increase in lagging safety performance. Overall, the R^2 value of 0.056 indicates teaching-based safety training contributed to 5.6% change in lagging safety performance while 94.40% were contributed by other factors and constructs not considered in the model. Thus, the model that expresses the relationship between lagging safety performance and teaching-based safety training is presented in Equation (4):

$$AO = 0.057TST + 4.998 \quad (4)$$

Table 1. Simple linear regression analysis for safety participation

MODEL		B	Std. Error	R^2	t	p-value
SP	(Constant)	3.438	0.242		14.202	0.000
	TST	0.074	0.082	0.03	0.895	0.371

Note: TST = Teaching-Based Safety Training, SP = Safety Participation

Table 2. Simple linear regression analysis for safety compliance

Model		B	Std. Error	R^2	t	p-value
SC	(Constant)	4.356	0.192		22.659	0.000
	TST	0.263	0.065	0.098	4.032	0.000

Note: TST = Teaching-based Safety Training, SC = Safety Compliance

Table 3. Simple linear regression analysis for safety performance on safety training

Model		B	Std. Error	R^2	t	p-value.
AO	(Constant)	4.998	0.268		18.664	0.000
	TST	0.057	0.091	0.056	0.623	0.534

TST = Teaching-Based Safety Training, AO = Accident Occurrence

3.2 Structural Model Analysis

3.2.1 Structural Model for the impact of teaching-based safety training on leading and lagging safety performance

Null Hypothesis: H1o. Teachig-style safety training has no significant impact on the leading safety performance of selected oil and gas companies operating in the Niger-delta

Alternative Hypothesis: H1i. Teaching-style safety training has significant impact on the leading safety performance of selected oil and gas companies operating in the Niger-delta

Null Hypothesis: H2o: Teaching-style safety training has no significant impact on the lagging safety performance of selected oil and gas companies operating in the Niger-delta.

Alternative Hypothesis: H2i: Teaching-style safety training has significant impact on the lagging safety performance of selected oil and gas companies operating in the Niger-delta.

Fig. 2 shows the path analysis model on the impact of teaching-based safety training on leading and lagging safety performance. Leading safety performance was captured using safety compliance and safety participation and lagging performance was captured using accidents occurrence. Table 4 shows the path analysis regression model results obtained from the structural equation model. From the value and sign of the estimated regression weight as well as p-value, it was observed that teaching-based safety training has positive and significant impact on safety compliance but positive and insignificant impact on safety participation and lagging safety performance. Hence, it can be stated that increase in level of teaching-based safety training of the workers would trigger increase in both leading and lagging safety performance. The increase in lagging safety performance will be insignificant while that of the leading safety performance will be significant with respect to safety compliance but insignificant with respect to safety participation. Thus, we will accept null hypothesis (H1o), which states that teaching-based safety training has no significant impact on leading safety performance with respect to safety participation as a construct of leading safety performance and reject it on the bases of safety compliance. However, we will completely accept null hypothesis (H2o), which states that teaching-based safety training has no significant impact on lagging safety performance.

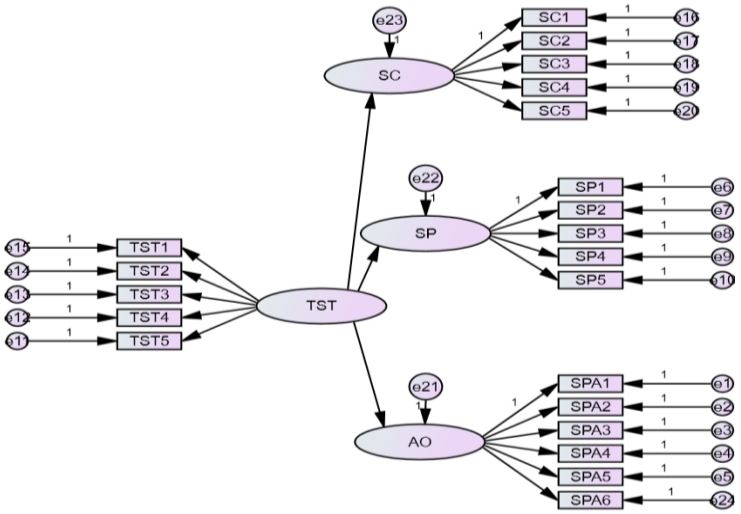

Fig. 2. Path analysis model of the impact of teaching-based safety training on leading and lagging safety performance

Table 4. Path analysis regression results on impact of teaching-based safety training and constructs of leading and lagging Safety performance

Relationship Path			Regression Weight	S.E.	C.R.	P-value
SP	<---	TST	0.020	0.093	0.210	0.534
SC	<---	TST	1.371	1.359	2.009	0.000
AO	<---	TST	0.052	0.269	0.113	0.312

Note, TST = Teaching-Based Safety Training, SP = Safety participation, AO = Accidents Occurrence, SC = Safety Compliance. S.E = Standard Error. CR = Critical Ratio

3.2.2 Structural model for the mediating effect of leading safety performance on teaching-based safety training and lagging safety performance

Null Hypothesis: H3o. Leading safety performance did not significantly mediate in the relationship between lagging safety performance and the teaching-based safety training in selected oil and gas companies operating in the Niger-delta

Alternative Hypothesis: H3i. Leading safety performance significantly mediate in the relationship between lagging safety performance and the teaching-based safety training in selected oil and gas companies operating the Niger-delta

Fig. 3 shows the path analysis model on the mediating effect of leading safety performance constructs, safety compliance and safety participation, on the relationship between teaching-based safety training and lagging safety performance. Lagging safety performance was captured using accidents occurrence. Table 5 shows the path analysis regression model results obtained from the structural equation model. From the value and sign of the regression weight as well as the value of the p-value, it was observed that safety compliance has a positive, significant and complete mediating effect on the relationship between teaching-based safety training and lagging safety performance, while safety participation has a positive, insignificant and partial mediating effect between the same constructs. This implies an increase in teaching-based safety training would have to enhance the safety compliance of the workers before reduction in accident occurrence. Otherwise, increasing the teaching-based safety training cannot directly reduce occurrence of accident without first improving the safety compliance of the workers. This can be observed in the insignificant relationship between accident occurrence and teaching-based safety training. Thus, there must be a mediating factor required to make the relationship significant, in this case, safety compliance. Whereas increasing teaching-based safety training would positively enhance the safety participation of the workers, but this improvement will have no significant effect in reducing accident occurrence. Thus, the null hypothesis (H3o) which states that leading-based safety performance does not mediate in the relationship between teaching-based safety training and lagging safety performance is rejected with respect to safety compliance as a construct of leading safety performance and is accepted with respect to safety participation.

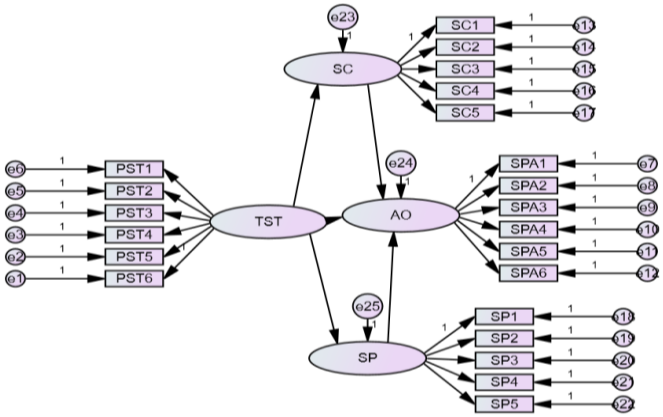

Fig. 3. Path Analysis Model of the mediating effect of leading safety performance factor on relationship between Teaching-based safety training and lagging Safety performance

Table 5. Path analysis regression results on mediating effect of leading safety performance on teaching-based safety training and constructs of lagging safety performance

Relation	Path Weight	P-value	Conclusion
AO ---> TST	0.052	0.321	Insignificant
AO ----> SC ------> TST	1.056	0.000	Complete mediation effect
AO ----> SP ------> TST	0.034	0.051	Partial mediation effect

Note, TST = Teaching-Based Safety Training, SP = Safety Participation, AO = Accidents Occurrence, SC = Safety Compliance

4. CONCLUSION

Based on the results of the study as presented and discussed, it was concluded that teaching-based safety training has positive impact on both safety compliance and safety participation of workers in oil and gas companies operating in Niger-delta. However, while the impact on safety compliance is significant, the impact on safety participation is not significant. Teaching-based safety training also has positive but insignificant impact on reduction of accident occurrence which translate to positive and insignificant impact on lagging safety performance. Finally, only safety compliance has complete mediating effect on the relationship between accident occurrence and teaching-based safety training.

5. RECOMMENDATIONS

The following recommendations are noteworthy:

1. The management of the oil and gas companies should endeavor to hire qualified trainers who are experienced & grounded in the theoretical aspect of safety in the oil and gas industries as such would help to enhance the safety compliance and safety participation of the workers and by extension reduce the likelihood of accident occurrence.
2. The management of the oil and gas companies should design means and techniques to motivate and encourage their workers to take theoretical aspect of safety training serious as such would enhance their safety compliance and safety participation and by extension help to reduce the cases of incident and accident occurrence.
3. The government agencies and regulatory bodies in oil and gas sector should ensure that there is regular and continuous review of all safety programs and policies concerning safety training to accommodate changes in the oil and gas business environment and modern developments in safety management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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