Analysis of health safety environment (HSE) training to major risk prevention using structural equation model

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Abstract. One effort that is considered very effective by the company is by building and increasing Health Safety Environment (HSE) awareness for all oil and gas workers. The efforts made by companies to develop and increase HSE awareness are by providing HSE compulsory training. This study aims to study how much influence HSE training has on the prevention of the main risks of well service activities in the oil and gas industry. Data was taken from the questionnaire given to 100 respondents in the weld services. Data was analyzed using SEM AMOS (Analysis of Moment Structures) method. The internal data of the company has recorded a significant increase in the number of occurrences of workplace accidents caused by a lack of HSE awareness. The study has compiled a matrix of HSE compulsory training that should be provided to all employees to increase HSE awareness to avoid the risks of major risk well services such as explosions, explosions of Fire and Gas and oil spills. The results of the company's internal analysis show that the lack of HSE training for new employees and old employees as refreshment was one of the root causes of lack of HSE awareness in the work environment. As a result, the provision of HSE training significantly improves to prevent the main risks of weld service activities.

Keywords: Major risk, training, SEM, HSE, weld services

1. Introduction

There are several challenges to increase oil and gas production to achieve the national oil and gas production target. The biggest challenge that must be faced by companies in an effort to achieve an increase in oil and gas production targets is the challenge of producing oil and gas from mature fields that must be developed in a special way, because the Oil and Gas block has different reservoir characteristics from most fields. Another challenge is the management of human resources in managing the increasing number of workers which of course involves new and inexperienced employees. In connection with the high lifting target, the target needs to be anticipated with increasing activity in the upstream industry itself. From seismic activities to finding new oil fields and new reserves. Also, activities on the oil field itself. One of them is increasing activities is in the drilling and well service activities. These increasing activities are certainly a challenge because it requires good anticipation for the procurement of materials, increased manpower, and of course an increased risk of accidents [1]
In general, the risk increases and associated with increased activity. The major risk in drilling and well service activity is identified as Blowout. This is the uncontrolled release of crude oil and / or natural gas from an oil well or gas well after pressure control system have failed. Indonesia in the last 35 years has been blowout 17 times, which shows that almost every 2 to 3 years a blowout accident occurs during well drilling [2]. Fire and explosion due to the burning of fluids or combustible gases such as hydrocarbons. These fluids are always presence in drilling and well service activities [3]. Hydrocarbon release and oil spill is the release of hydrocarbons (oil and gas) into the air, water and soil environment which can cause environmental damage, contamination of polluted habitats / animals and plants [4].

The area of work safety in the world of engineering includes the involvement of humans both workers, clients, and company owners [5]. Referring to the Incident Case taken from the database in Well Service Department (WSD) from January 2016 to December 2017, has shown that there is a significant increase in the number of reported cases related to lack of HSE awareness. Incident related to lack of HSE awareness for example: Incident related to manual handling, Gesture Posture [6], Electrical shock injury, Slip and trip injury, falling from heights, working without permit [7].

In 2016 there were 761 cases related to lack of HSE awareness. 6.2% of the total cases recorded in the Company. In 2017 there were 1854 cases of lack of HSE awareness reported. This is 10.96% of the total 17059 cases recorded in the Company. The Lack of HSE awareness case trend increased from 6.2% to 10.9%. One effort to suppress, reduce or even eliminate employment accidents is by providing training. Training is one of the important tools in ensuring the work competition needed to achieve occupational safety and health goals [8]. Other aspects that are believed by the company are one of the benchmarks for the success of work safety management performance in upstream oil and gas operational activities is characterized by low rates of work accidents. To find out the magnitude of the number of accidents one of them can be done by calculating the Incident Rate value (IR) [9]. HSE (Health, Safety and Environment) is a series of businesses to create a safe and peaceful working atmosphere for employees who work in the company concerned [10].

This research aims to analyze the influence of providing HSE training on prevention of major risk using Structured Equation Model in weld services. In addition, this study also to determine the correlation between health, safety and environment in order to support the company the significant conducting the training program.

2. Materials and Methods
Data analysis from internal companies refers to several events reviewed by the Fishbone analysis method. Figure 1 shows the fish bone analysis of major injury in weld services.

![Fishbone analysis](image-url)

**Figure 1.** Fishbone analysis
From several incidents had been occurred, it was concluded that the Lack of knowledge is the root cause of a large number of incidents that occur. In this study several variables were used to support research using the SEM method exogenous and endogenous variables [11].

Exogenous variables used in this study include variables: giving HSE training (Health, Safety and Environment). Endogenous variables used in this study include two constructs, namely the prevention of major hazards in wel service activities in the oil and gas industry. Data used in problem solving is obtained from two sources, namely, primary data and secondary data [12]. Secondary data is data obtained from the company’s internal data, while the primary data is obtained from the employees of the well service section in the company selected as the respondent. Sampling is done by stratified random sampling 100 respondents.

In this study the data sources used are primary and secondary data on the company. Primary data will be obtained directly to employees. Data collection in this study uses a questionnaire method, which is a method in the form of a series or collection of questions arranged systematically in a questionnaire then sent to respondents to be filled. The questionnaire was used to respond to research respondents to find out: the effect of providing HSE (Health, Safety and Environmental) training on the prevention of major hazards in Wel Service activities in the oil and gas industry in the XYZ company. The questionnaire collected was then tested for validity and reliability.

Subsequent analysis after the measurement model was analyzed through confirmatory analysis factors. It was seen that each variable can be used to define a latent construct, so that the full model of Structural Equation Modeling (SEM) can be analyzed. The results of processing data for analysis of SEM models are shown in figure 2:

![Figure 2. SEM full model](image)

3. Results and Discussion

The CFA (Confirmatory Factor Analysis) test is performed on exogenous and endogenous constructs, used to assess the validity of each questionnaire item, while the model suitability test (normality test, outlier test, multicollinearity test, Goodness of fit test, and reliability test) is carried out on the full structural model. The CFA test or construct validity test is intended to find out whether each indicator can explain the existing construct. The indicators used to measure the research variables were indicators that have p value <0.05 and loading factor > 0.5, while indicators that have p value > 0.05 and loading factor <0.5 were eliminated from the model.
In this part, the significance value (P value) is accepted if more than 0.05, while below 0.50 then the indicator is dropped because it is considered invalid to measure the latent construct. The result of CFA test for exogenous variables can be seen in Table 1.

Table 1. Regression weight

| Label | Estimate | S.E. | C.R. | P  | Label |
|-------|----------|------|------|----|-------|
| Y11   | Prevention| 1.000|      |    |       |
| Y12   | Prevention| 1.019| 0.151| 6.748| *** par_1 |
| Y13   | Prevention| 1.008| 0.153| 6.675| *** par_2 |
| Y14   | Prevention| 0.999| 0.146| 6.840| *** par_3 |
| Y15   | Prevention| 0.888| 0.142| 6.235| *** par_4 |
| Y16   | Prevention| 1.038| 0.152| 6.842| *** par_5 |
| Y17   | Prevention| 0.997| 0.146| 6.817| *** par_6 |
| Y18   | Prevention| 0.999| 0.144| 6.935| *** par_7 |
| Y19   | Prevention| 1.046| 0.148| 7.086| *** par_8 |

Based on the output Regression Weight, at the P value (Probability), if the value was not significant (above 0.05) then the indicator must be deleted. Visible probability values mean significant at the level of 0.001 which means it is also less than 0.05, with this when viewed from the Regression Weight the indicator is valid all, but significant results do not necessarily provide a high loading factor (estimate value) (above 0.5).

The purpose of the model fit or Goodness of fit test is to find out whether the formed model is fit or not, namely whether the manifest variables (indicator variables) can explain the latent variables that exist. The result was presented using AMOS Output. Table 2 lists of assessment criteria for Goodness of fit and the results are as follows:

Table 2. Goodness of fit test

| Goodness of Fit       | Cut off value | Result | Decision |
|-----------------------|---------------|--------|----------|
| Probabilities Chi Square | ≥ 0.05 | 0.000 | Bad Fit |
| CMIN/DF               | ≤ 2.00        | 1.296 | Good Fit |
| GFI                   | ≥ 0.90        | 0.712 | Bad Fit |
| AGFI                  | ≥ 0.90        | 0.674 | Bad Fit |
| CFI                   | ≥ 0.90        | 0.924 | Good Fit |
| TLI                   | ≥ 0.90        | 0.918 | Good Fit |
| NFI                   | ≥ 0.90        | 0.739 | Bad Fit |
| IFI                   | ≥ 0.90        | 0.926 | Good Fit |
| RMSEA                 | ≤ 0.08        | 0.052 | Good Fit |
| RMR                   | ≤ 0.05        | 0.053 | Marginal Fit |

Testing of Structural Equation Modeling (SEM) analysis also carried out the model suitability test (Goodness of fit test) and the causality test through regression coefficient tests. Model Suitability Test - Goodness of Fit Test appears in Table 3 lists the results of the full factor analysis of the Structural Equation Modeling (SEM) model of the model conformity test:
After overall a structural model can be considered fit, the next process is to see whether there is a significant influence between the independent variables and the dependent variable. The summary results of the hypothesis test output are listed in Table 4.

**Table 3. Conformity testing of structural equation modeling analysis**

| Goodness of Fit Index | Cut Off Value | Result | Model Evaluation |
|-----------------------|--------------|--------|------------------|
| Chi-Square (df=128)   | (<109.77)    | 123,402| Good             |
| Probabilities         | ≥ 0.05       | 0.598  | Good             |
| RMSEA                 | ≤ 0.08       | 0.000  | Good             |
| GFI                   | ≥ 0.90       | 0.901  | Good             |
| AGFI                  | ≥ 0.90       | 0.867  | Good             |
| CMIN/DF               | ≤ 2.00       | 0.964  | Good             |
| TLI                   | ≥ 0.95       | 1.008  | Good             |
| CFI                   | ≥ 0.95       | 1.000  | Good             |

Refer to above output it can be concluded that there was a significant effect between Health and Prevention. The result depicts because the probability value was less than 0.05 (0.002 < 0.05). The negative estimate value was determined with the value of -7.374, which means that the effect was negative, thus if Health increases, prevention decreases. There was a significant influence between Safety and Prevention. Due to the Probability value was less than 0.05 (0.002 < 0.05). A positive estimate value of 8.251 means that the effect was positive. It indicates if safety increases then prevention also increases. There was no significant influence between the Environment and Prevention, due to the Probability value was determined more than 0.05 (0.065 > 0.05).

The provision of HSE Training, which can be said to be high or 3.41%, shows that the training about health was followed in accordance with work requirements. Safety determined with high or 3.48%. It shows that safety training that has been followed can be implemented and improve employee competency. Environment presented with high or 3.55%, it was indicating that the Environment training followed in accordance with work requirements. While prevention of major hazards in well service activities show a moderate value or 2.91%, it indicated that employees were in detailed exploration activities before field development plans were made and choose projects more carefully, by looking at the experience of previous developers.

The results of his research showed that there was a significant effect between Health on Prevention. HSE (Health, Safety and Environment) was a reflection of the company's goals and the way in which the objectives that must be fulfilled as determined by senior management's achievement of hazard management objectives will be realized through establishing a responsible organization assigned and for which resources are provided. Standards and procedures through which the objectives will be fulfilled was defined by people with the necessary expertise. Implementation of standards was
monitored through periodic audits. The audit was reviewed by management who can initiate system changes to facilitate improvements. This system needs additional directly through a feedback loop that corrects and corrects at a single stage.

The results of his research showed that there was a significant effect between Safety and Prevention. Health refers to general physical, mental and emotional stability in general. Occupational Health and Safety was a condition in work that is healthy and safe both for the work, the company and for the community and the environment around the factory or workplace. HSE (Health, Safety and Environment) shows the physiological-physical and psychological conditions of the workforce caused by the work environment provided by the company.

The results showed that there was no significant effect between environment to prevention. One of the risk controls measures that can be taken is to implement a work permit system. Safety aspects in work must be fulfilled so that work can be done safely and avoid potential hazards. Work permit documents are used to ensure work is safely carried out in the industry. The effect of the dominant significance between the Health, Safety and Environment factors on prevention of major risk was evidenced from the significant significance value between Safety and Prevention of the Probability value less than 0.05 (0.002 <0.05). Occupational Health and Safety is a condition in a healthy and safe work both for the work, the company and for the community and the environment around the factory or workplace. HSE (Health, Safety and Environment) shows the physiological-physical and psychological conditions of the workforce caused by the work environment provided by the company.

4. Conclusion
The provision of HSE has the major impact on environment field and followed by safety and health fields. The HSE training should be managed proportionally to these findings to improve employee competency. While the prevention of major hazards in wells service activities indicated that employees are in detailed exploration activities before field development plans are made and choose projects more carefully, by looking at the experience of previous developers, both technically and managerially.

Awareness of Health aspects increased by providing intensive HSE training during the 2017 - 2018 period in the form of an individual training matrix implementation where training is tailored to the needs or shortcomings of each employee that is different from one employee to another. This program should be managed intensively for the employee to reduce the major accident in well services. The training program matrix has successfully prevented the major risk. The results also determined the significant effect on prevention between of health and safety. However, there was no significant influence between environment and prevention. In addition, by focusing the training matrix, the number of incident related lack of HSE awareness also dropped dramatically by 87.8% from 370 cases to 45 cases.

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