Analysis of Factors that Affecting Safety Risk Perception in Oil Refinery Industry

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Abstract

This research examined the risk perceptions of workers in the petroleum processing industry sector. The background of this study was based on the exploitation, production, and distribution activities in the oil and gas industry sector which are extensively carried out to meet high market demand. However, it also needs to be balanced with a sound safety system to prevent workplace accidents. The main idea of this study was slightly different from previous research. The approach used is the perspective of workers to find safety risks that frequently occurred in their work environment. This study employed the structural equation modelling (SEM) method to find out the main factors that influence workers' perception of the occupational safety risk. Based on the result of the analysis, individual attitude & behaviour and work situation & target are two factors that have a strong influence on workers risk perception. This finding is essential for further analysis in developing action plans for accident preventions in a company, particularly in the petroleum processing industry sector.

Keywords
Safety Risk Perception, Structural Equation Modelling, Oil and Gas Industry.

1.   Introduction
The oil and gas industry in Indonesia have a very vital role in the sustainability of various community activities and operational activities of various industrial sectors. Oil and gas have become a vital commodity for the community. The public is increasingly aware that Indonesia's wealth of natural oil and gas resources has limitations. The amount of crude oil reserves continues to decline, but consumption and demand for petroleum continue to increase. Therefore, natural resources in the form of oil and gas must be managed well and safely, and their use must be in an efficient manner. Oil and gas operational activities in Indonesia can be classified as vulnerable to various hazards that have been mentioned, as evidenced by the many cases of work accidents in the Indonesian oil and gas operating environment (California Emergency Management Agency 2014).

The key to implementing a work safety management system in the petroleum industry environment is compliance with all regulations that have been established by the government. Starting from the competency standards of oil and gas workers in the work safety sector to the management of various types of sources of danger that are anticipated early on. Work accidents or risk of exposure to diseases due to accidentally touching chemicals that are included in the category of hazardous substances or germs can be avoided and minimized. The risk of fire or gas explosion that may occur due to the impact of oil and gas operational activities can also be reduced. In short, various kinds of risks in the operational activities of the oil and gas industry must be managed well (Hughes and Ferret 2003).

In this study, researchers want to contribute in the development of the Safety Risk Perception model to find out what factors affect Safety Risk Perception according to the perspective of workers at the refinery and provide recommendations for improvement on the factors that most influence to increase safety and prevent work accidents in the refinery environment reappears later on. Researchers will use 2 statistical methods, namely the linear regression method and the structural equation modelling (SEM) method. The two methods will give different results, but this will enrich the Analysis material to show what factors influence the risk perception of workers in the oil refinery environment. Later these factors can be used as a reference to provide suggestions for improvements to reduce the number of work accidents in the oil refinery environment (Wang and Zou 2015).

2.   Literature Review

2.1.   Safety Risk Perception

Risk perception can be defined as a subjective assessment of uncertainty about the likelihood of events that can occur and how concerned we are with the consequences. Everyone views risk differently and no two or more people always view the same risk in the same way (Pandit et al. 2018). How people perceive risk can be related to, for example, skills available to individuals, motivational factors, past experiences, etc. Perception about risk affects the level of safety but both are an interrelated paradox. if someone is successful in perceiving, recognizing and deciding to avoid danger will lead to safe behavior and vice versa if someone fails in these stages it will lead to dangerous behavior that can result in workplace accidents. Risk perception greatly contributes to the main activity Safety work namely "risk management" (Phoya 2011).

2.2.   Structural Equation Modelling (SEM)

Structural equation modelling (SEM) is a statistical technique used to build and test statistical models that are usually formed in the form of causal models. SEM is actually a hybrid technique that includes the confirmatory aspects of factor analysis, path analysis and regression that can be considered as special cases in SEM. It was also stated that SEM was used to estimate simultaneously the causal relationship between many independent variables and the dependent variable. The SEM method can be used to see the causal relationship between an individual and his organizational factors in work safety behaviour in an organization. Other researchers state that the outcome of this procedure is the goodness-of-fit value used to increase the level of measurement scale, that is, the indicator variable, through the associated latent construct (Chang Seo 2014).

There are several stages in the Structural Equation Modelling (SEM) method:
1. Development of Theory Based Model
    It can be defined as a process of characterizing or developing a model that has a strong theoretical justification. In addition, the model will be validated empirically through the SEM program computational process, where SEM is not used to produce a model but is used to confirm the theoretical model through empirical data.
2. Creating a Path Diagram
    Path diagrams make it easy to see the causal relationship between the variables being tested. Constructs built in the Path Diagram are divided into two groups, namely exogenous constructs and endogenous constructs.
3. Confirmatory Factor Analysis (CFA)
    CFA is used to test whether the indicators used are valid indicators as a measure of latent constructs. The construct is said to be valid if the factor loading value is above 0.5. At this stage the reliability test is also carried out by looking at the value of constructability.
4. Model Match Test
    At this stage the indications that can be used to measure how the model is fit with observational data are: chi-square, goodness-of-fit (GFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA) (Hall 2006).

2.3.   Research Gap

Table 1 shows the research gap of this study.

Table 1. Research gap.

Authors, year	Topics	Tools	Research Object
Nektarios Karanikas, Damien Jose Melis, Kyriakos I. Kourousis. (Karanikas 2017)	- Balance between safety and productivity - Relationship with human factors & concern for safety and communications	- Questionnaire with Likert scale 1-4 - Hypothesis testing - Bivariate Analysis	Airplane Manufacturing Industry
Iraj Mohammadfam, Mojtaba Kamalinia, Man sour Momeni, Rostam Golmohammadi, Yadollah Hamidi, Alireza Soltanian. (Mohammadfam 2017)	- Evaluate the application of OHSAS in the company's management system based on the company's KPI	- OHSAS 18001 - Mann-Whitney U test	Some certified organizations (company name not mentioned)
Muhammad Ragil Suryoputro, Amarria Dila Sari, Ratih Dianingtyas Kunia. (Ragil Suryoputro 2015)	- Analysis the cause of the train accident - Describe the factors and chronology of accident events using the Swiss cheese theory	- Swiss Cheese Model as Conceptual Framework - Swiss Cheese Model as based for analysis	Train accident at Petarukan station
Gusti Wira Bayutama (Bayutama 2017)	- The influence of organizational culture and safety climate - Compliance with safety regulations	- Multivariate Normality Test - Structural Equation Modelling - Confirmatory Factor Analysis	2 Warehouse PT Pertamina Lubricants in Surabaya & Gresik
Handy Febri Satoto (Satoto 2016)	- The influence of organizational management - Physical Working Environment Conditions - Work Safety Behaviour	- Multivariate Normality Test - Structural Equation Modelling - Confirmatory Factor Analysis	2 Manufacturing Industry: PT ABC dan PT XYZ
Nanta Sigit (Sigit 2016)	- Organizational culture and institutional aspects of safety behaviour - Factors of work accidents	- Multivariate Normality Test - Structural Equation Modelling - Confirmatory Factor Analysis	3 Shipbuilding Industries in Surabaya & Madura
This study	- Safety Risk Perception for workers in oil refinery industry - Determine the most influential factors in workplace accidents	- Structural Equation Modelling (SEM)	Refinery Unit in Central Java PT X

3.   Methods

Data is collected by distributing questionnaires to respondents, then the answers will be processed using structural equation modelling. There is a framework of this research.

The following are the stages carried out in this study. In general, this research is divided into 3 stages.

Stage 1:
In the initial stage, a literature study process is carried out on matters related to this main research topic. Among them are perceptions of safety risks, potential hazards at refineries, and Structural Equation Modelling (SEM) methods.

Stage 2:
After discussing some theories that address this research topic, latent variables and indicator variables are used to measure perceptions of safety risk from the worker's perspective. The variables are arranged from several references and designed a model. The model was designed by this author is called the initial model. From the initial model, a questionnaire will be designed for workers. Where each indicator variable is developed into 1 question item. Total respondents who answered the study were 80 workers.

Stage 3:
Next, a field test is conducted. Where the authors visited the site for a work safety management system in the refinery area, as well as distributing questionnaires to workers in the refinery environment. After getting the results of the questionnaire, the results will be recapitulated, then analysis using the Structural Equation Modelling method (SEM). Furthermore, the output from the SEM method will show what factors have an influence on the perception of safety risk. In the next stage, factors which have an influence on the perception of safety risk will be carried out. Furthermore, the results of this analysis will be developed into an improved repair to improve the perception of safety risks of workers in the environment and prevent damage that occurs in the future.

4.   Results and Discussion

From the flowchart, the author makes a structural equation modelling based on several references. This model consists of latent variables and indicator variables. Where each latent variable has several indicator variables. Indicator variables will be used as a reference for creating questionnaire questions. Figure 1 is the model developed by the authors by combining multiple reference.
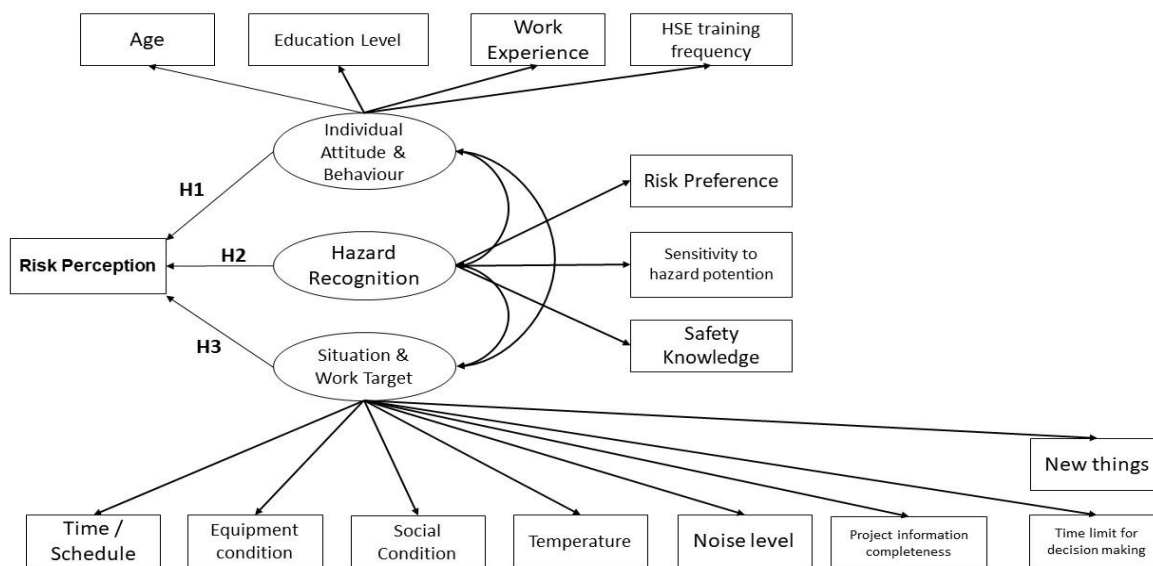

Figure 1. Initial model Structural Equation Modelling.

Table 2 shows an explanation of the three latent variables found in the structural equation modelling above.

Table 2. Latent variable description.

No.	Latent Variable	Description
1.	Individual Attitude & Behaviour (Phoya 2011)	Consists of internal factors inherent in each individual respondent, as well as external factors that are influenced by the work environment.
2.	Hazard Recognitions (Pandit, et al. 2018)	The ability of respondents to recognize various hazards around their work environment, as well as preventive actions taken by respondents to prevent work accidents.
3.	Situations & Work Target (Wang and Zou 2015)	Consists of various factors related to physical conditions and social conditions in the work environment, as well as work targets set by the company.

From that model, the result from structural equation modelling method would eliminate some factors that don't have a significant impact on the safety risk perception. Factors that have an influence on the safety risk perception will be used as a reference in making recommendations for improvements for the company to prevent work accidents in the future. Figure 2 shows the final model which contains factors that have a significant impact on SRP of workers in the refinery work environment.
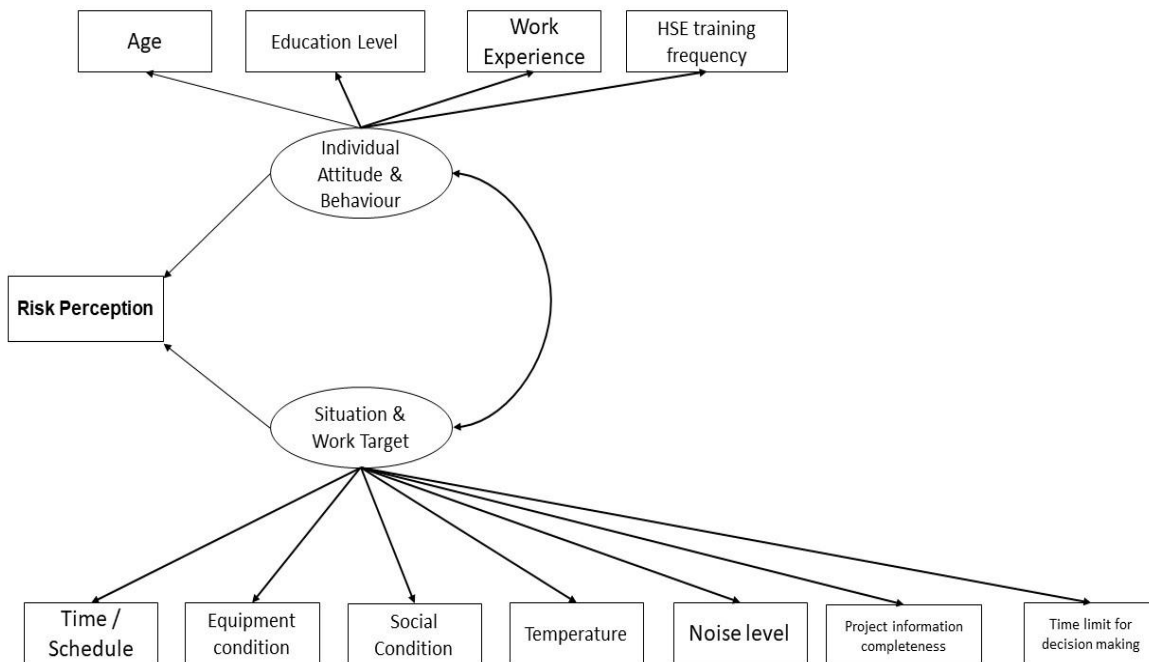

Figure 2. Final model Structural Equation Modelling.

5. Conclusion

Work accidents, especially in the petroleum processing industry sector, are not something that cannot be avoided. One effort to prevent work accidents is by anticipating unsafe actions and unsafe behaviour long before the accident occurs. Another effort is to map the factors that have an influence on risk perception from the perspective of the worker. Based on the results of this study, it can be concluded that the main factors causing occupational accidents are individual attitude & behaviour and situation and work target. So, the company can make improvement in these factors to avoid occupational accidents happen later on. Where workers spend a lot of time directly in the work location with various kinds of hazards attached to their work. By doing this research, it will provide benefits to find out the factors that influence the safety risk perception of workers in the oil refinery industry.

References

California Emergency Management Agency, *Improving Public and Worker Safety at Oil Refinerie,* Report of the Interagency Working Group on Refinery Safety, Sacramento, 2014.

Bayutama, G. W., Pengaruh budaya organisasi dan iklim keselamatan terhadap kepatuhan peratuan keselamatan warehouse PT. Pertamina Lubricant, *Thesis* (unpublished), Institut Teknologi Sepuluh Nopember, Surabaya, 2017.

Chang Seo, H., Analyzing safety behaviors of temporary construction workers using structural equation modeling, *Safety Science,* vol. 77, pp. 160-168, 2014.

Hall, M.E., *Measuring the Safety Climate of Steel Mini-mill Owkers using an Instrument Validated by Structural Equation Modelling,* The University of Tennessee, Knoxville, 2006.

Hughes, P., and Ferret, E., *Introduction to Health and Safety at Work,* Elsevier, New York, 2003.

Karanikas, N., The balance between safety and productivity and its relationship with human factors and safety awareness and communication in aircraft manufacturing, *Safety and Health at Work,* vol. 9, no. 3, pp. 257-264, 2018.

Mohammadfam, I., Evaluation of the quality of occupational health and safety management systems based on key performance indicators in certified organizations, *Journal Safety and Health at Work,* vol. 8, no. 2, pp. 156-161, 2017.

Pandit, B., Albert, A., Patil, Y., and Al-Bayati, A. J., Impact of safety climate on hazard recognition and safety risk perception, *Safety Science,* vol. 113, pp. 44-53, 2018.

Phoya, S, Assessment of health and safety risk perception of site managers, supervisors and workers in Tanzania urban construction sites, *Proceeding of CIB W099 Conference of International Council for Research and Innovation in Building and Construction,* 2011.

Suryoputro, R. M., Preliminary study for modeling train accident in Indonesia using swiss cheese model, *Procedia Manufacturing,* vol. 3, pp. 3100-3106, 2015.

Satoto, H. F., Pengaruh manajemen organisasi dan kondisi lingkungan kerja fisik terhadap perilaku keselamatan kerja di industri manufaktur, *Thesis* (unpublished), Institut Teknologi Sepuluh Nopember, Surabaya, 2016.

Sigit, N., Pengaruh budaya organisasi dan aspek kelembagaan terhadap perilaku keselamatan di shipbuilding industries*, Thesis* (unpublished), Institut Teknologi Sepuluh Nopember, Surabaya, 2016.

Wang, J, and Zou, P. S., Critical factors and paths influencing construction workers safety risk tolerances, *Accident Analysis and Prevention*, vol. 93, pp. 267-279, 2015.