Development Models of Personality, Social Cognitive, and Safety Culture to Work Accidents in the Chemical Company

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Abstract. Mental errors caused by anxiety, attitude, fear, stress, personality, or emotional state can cause accidents. To prevent workplace accidents, understanding the workers’ personality that reflect the pattern of psychological characteristics, thought, emotion and behavior is important. Personality is a basic human characteristic that is influenced by the social and cultural environment called socio-cognitive. A safety culture approach to the reducing accidents emphasizes the role of social forces in organizations regarding safety. This study aims to determine the relationship of personality, social cognitive, and safety culture to workplace accidents in the chemical company. The data was collected by distributing questionnaires to 73 workers, including the production area and the field workers in a chemical factory, the data is statistically tested by using PLS-SEM. The PLS-SEM used to determine the relationship between personality traits and safety culture (H1), the relationship between social cognitive and safety culture (H2), and the relationship between social cognitive and personality traits (H3) in chemical company. The test results show that the three hypotheses were accepted. This lead to the conclusions that personality traits have a positive relation to the safety culture; social cognitive have a positive relation to safety culture; and social cognitive have a positive relation to personality traits. In conclusion, personality traits, social cognitive, and safety culture are interrelated.

1. Introduction

The International Labor Organization (ILO) states that the number of work injured and dead victims in developing countries is still quite high every years. There are 250 million accidents occurs in a year that equivalent to 685,000 accidents every day [1]. In Indonesia, the number of work accidents is also relatively high. Data from [2] record 147,000 cases of work accidents every year. Among those accidents, 4,678 cases cause disabilities and 2,575 cases ended up in death. Workplace safety and health have been improved, but new occupations cause new hazards including problems with musculoskeletal disorders, asthma and allergic reactions, stress and mental illness, and diseases caused by dangerous exposures and carcinogenic agents, such as radiation, asbestos, and chemical material [1]. Chemical burn injury is a special category that must be known by professional safety practitioners. The largest incidence of chemical burns occurred at the factory. The other high-incidence industries are the services industry, trade industry, and construction. Nearly 46% of all chemical burns occur when workers are cleaning equipment and vehicles. This is under the theory of accident-causing systems where accidents can occur as a system consisting of the following components: human,
machine, and environment. The likelihood of an accident is determined by how these components interact. Changing patterns of interactions can increase or reduce the possibility of work accidents [3]. In the early 1900s, the evolution of work accident prevention focused on finding the psychological causes of accidents. It is assumed that humans are responsible for most accidents and injuries, usually through mental errors caused by anxiety, attitudes, fears, stress, personality, or emotional states [4]. Thus, this study will examine one psychological approach that causes workplace accidents, namely personality. It is known that humans are the most important factor in the sustainability of a company. Every human being has different characteristics in terms of his personality which is a stable and unique psychological trait, which reflects the pattern of a person's psychological characteristics and mechanisms [5]. This personality variable also has a social basis [6]; they develop through experience with the socio-cultural environment of someone who is labeled social-cognitive. The cognitive theory of social personality has a defining characteristic namely the principle of reciprocal determinism. People and social settings are seen as systems that interact. The socio-cultural environment contributes to the development of personality structures [7]. Mutual transactions between organisms and the environment are basic features of biological life. Another decisive feature of social cognitive social theory is the concept of personality functions and differences between individuals. Personality is understood by referring to basic cognitive and affective structures and processes [8].

The social-cognitive theory contrasts with the theoretical-trait perspective known as the five-factor theory [9]. The five-factor theory is the result of a series of very consistent empirical findings. In various methods of assessment, language, culture, and differences between individuals can be well explained through the use of the five-factor theory [10]. Also, a large number of studies in Indonesia and internationally have investigated the role of personality as a predictor of work safety [11]. The majority of this work looks at personality with the big five personalities or also commonly called the five-factor model [9], which consists of openness to experience, conscientiousness (consciousness), agreeableness (conformity/agreement), neuroticism, and extraversion. The five-factor model of personality is one of the most prominent models in contemporary psychology to describe the strongest aspects of personality. Work accidents cause of a weak safety culture in a company [12]. Organizations with a strong safety culture are more effective in preventing large-scale industrial accidents and personal injuries at work [13]. Safety culture is part of organizational culture and refers to individuals, jobs, and organizational characteristics that affect employee health and safety [14]. This factor also influences attitudes and behaviours related to the safety of organizational members and reduces violations. In previous studies, safety attitudes, safety awareness, and safety behaviour are included in factors that influence safety culture in various industries [15]. Negative attitudes, poor safety awareness, and unsafe behavior can cause industrial work accidents. In the work environment, it is found that work accidents are caused by individuals who have the same personality pattern tendency seen from their behavior. Previous research has shown a strong relationship between personality and behavior related to safety (safety behaviour). Knowing the personality of each individual can provide predictions of performance and safety behavior at work. Safety assessment can be included as part of the recruitment process for the company to hire individuals who have safe behavior that will minimize the risk of future work accidents. Besides, it can also be used for the development of employees, how they understand their personality will affect work safety and they must be responsible for it, how they build a safe situation, can identify employees who have a risk tendency, and do coaching about safety [3].

The chemical industry plays an important role that is responsible for converting raw materials such as natural gas, oil, water, air, minerals, and metals into more valuable products. Chemicals are substances that play an essential role in everyday life but are also dangerous if they do not understand correctly how to use and maintain them. Maintaining and improving safety and efficiency in the chemical industry requires knowledge of safety culture in attitudes and behavior. Knowledge about safety culture is important in all industries especially the chemical industry, because this industry worker faced with the potential danger of chemicals that will interfere with the safety and health of workers, the environment, and factory facilities. This research was conducted to develop a model of
the relationship of personality, social cognitive, and safety culture to work accidents in the chemical industry with the Structural Equation Modeling (SEM) method. Analysis and interpretation results of the questionnaire are desirable to provide more knowledge about the concept of safety culture in the chemical industry that is effective in preventing workplace accidents.

2. Literature Review

2.1. Safety Culture
Since the Chernobyl nuclear power plant accident in 1986, the company’s safety culture has become a focus, and has been involved in the cause of accidents by many large-scale industrial accident investigations. Culture in hazardous industries is related to safety, which is defined as "the ability of individuals or organizations to face risks and hazards to avoid damage or loss and still achieve their goals" [16]. The most important job in safety culture is to study the attitudes that workers have regarding security [17]. Key elements and explanations of how to engineer safety culture are conceptualized as the engine that moves the organization towards maximum operational safety goals. The strength of this machine is highly dependent on the ongoing respect for the potential hazards associated with organizational activities [18].

2.2. Factors Affecting Safety Culture
The factors that most influence safety culture include safety behaviour, safety attitudes, and safety awareness. Safety culture has been designated as a predictor of worker safe behavior. In a study of the relationship between safety culture and safety behaviour, [19] found that lower safety culture scores in the coastal cargo sector are associated with higher levels of unsafe behavior. As mentioned in the background, unsafe actions according to Heinrich's theory constitute 88% of the causes of workplace accidents. Safety attitudes are reflections of individual perceptions relating to safety policies, procedures, and practices [20], including one's obligations and feelings of individual duty towards safety. Safety attitudes are categorically related but separate from the safety climate of a group or organization level [21] or shared employee awareness about organizational policies, systems, and practices related to safety, which can be summarized as safety antecedents [22]. Awareness of the concept of safety culture gradually spread to the academic community, institutions, companies, and consulting firms, sometimes with limited appreciation of the complexity of the underlying ideas. A too simple understanding of safety culture and the possibilities for changing it will not produce the desired results. Safety culture is then often associated with awareness of danger [23].

2.3. Personality
Personality comes from Latin; persona, which refers to the mask worn by Roman actors in a performance. The actor acts according to the mask he wears as if the mask represents the characteristics of a personality. [24]. Personality is a very complex field of human behavior, in which empirically valid generalizations are not easily made or formulated [25]. Personality is a unique pattern of behaviour, karma, thinking, motives, and emotions, which gives character to individuals all the time and in a variety of different situations. This pattern includes many traits, which is a characteristic of someone who describes the behaviour, thoughts, and feelings that have become a habit. The concept of trait suggests that personality is rooted in individuals [26].

2.4. Type of Personality
Trait theory in psychology is a trend to emphasize the importance of stability parameters in human personality. Carl Jung is considered one of the first to emphasize the personality approach. “Big-Five Personality Traits” is one of the best known that characterizes humans in one or more of the following five characteristics [27]:

...
a. Openness
Openness is a comprehensive personality dimension related to the level of inconsistency, curiosity, independence, creativity, originality, imagination, and acceptance of diversity [28]. Openness to experience is an individual's tendency to be imaginative, sensitive, original in thinking, paying attention to inner feelings, valuing art, intellectually curious, and sensitive to beauty [10].

b. Agreeableness
Agreeableness type are friendly people, kind, caring, generous, trustworthy, helpful, cooperative and willing to compromise their interests with others [29]. Agreeableness correlates with fewer self-reported accidents in the workplace [30]. A meta-analysis shows that the type of agreeableness is a valid predictor and can be generalized for fewer workplace accidents. Agreeableness is a tendency to believe, be obedient, care, caring, generous, and gentle. Such individuals have an optimistic view of human nature. They sympathize with others and have a desire to help others [10].

c. Conscientiousness
Conscientiousness is an individual who is conscious of having purpose and determination. They tend to act obediently, show self-discipline, and aim to excel at some outside measure or expectation. Conscientiousness describes the control of social impulses that facilitate behavior directed at tasks and goals, such as thinking before acting [31].

d. Extraversion
Extraversion is a tendency to prefer social activities [32]. Extraversion is shown by positive feelings (emotions) and a tendency to find other people's friends. It represents a tendency to be sociable, assertive, active, cheerful, cheerful, optimistic, and talkative. Individuals like people, prefer groups, enjoy excitement and stimulation, and experience positive effects such as energy, enthusiasm, and excitement [5].

e. Neuroticism
People who are high in neuroticism are more susceptible to anxiety, self-awareness, and stress, whereas people who are low in neuroticism (ie, high emotional stability) tend to be calmer, safer, and confident [33]. With these characteristics, individuals with lower neuroticism are better able to form positive interpersonal relationships and successfully complete work assignments - even in the face of stressful situations - reflecting a tendency to achieve higher goals of fellowship and achievement, respectively [34]. Workers who have neuroticism type obey the regulations in their work environment, one of which is compliance with workplace safety regulations that are strictly regulated by the company [35].

2.5. Social Cognitive Theory
The social cognitive theory recognizes social contributions to the way humans think, act, and the importance of cognitive processes on motivation, emotions and actions. The basis of social cognitive theory which is briefly reviewed is human behavior in terms of one-sided determinism. In modes such as unidirectional causes, behavior is described as something that is shaped and controlled either by environmental influences or by internal dispositions, but social cognitive theory prefers a causal model that involves triadic reciprocal determinism. In this reciprocal causal model, behavior, cognition and other personal factors, and environmental influences all operate as determinants that influence each other in two directions [36]. In social cognitive theory, individuals are seen as having proactive abilities to regulate themselves outside of biological power and their environment. Besides, individuals are seen as having self-beliefs that enable them to measure control over their thoughts, feelings, and actions. Social Cognitive Theory has rooted in the view of the human agency that individuals are agents who proactively include environmental conditions and have control over their actions. Individuals have self-beliefs that can enable them to practice controlling their thoughts, feelings and actions that what is thought will affect their actions [37].
2.5.1. Self-Efficacy
Self-efficacy is one of the increasingly recognized psychological constructs specifically related to how people's belief in their ability to influence the environment and control their actions in a way that produces the desired results [38]. Self-efficacy is the belief about the extent to which a person estimates his ability to carry out a task or perform an action that is needed to achieve a certain result. Self-efficacy is related to one's capability in mobilizing motivation, cognitive resources, and all the efforts needed to meet the situational goals faced [7].

2.5.2. Self-Regulations
The process of regulating one's thoughts, feelings, and actions systematically to achieve one's goals is called self-regulation. This self-regulation repertoire makes it possible to shape the results of one's own life and may be one of the most vital and influential components of the human side [39] which is planned and cyclically adjusted to the achievement of personal goals [40]. Self-regulation is not entirely an intrapsychic affair. Rather, it involves mutual influence between thoughts, behavior, and social influence networks [41]. According to Bandura, self-regulation operates through a series of psychological sub-functions: self-monitoring sub-function, assessment sub-function, and self-reactive influence [42].

2.5.3. Human Agency
In social cognitive theory, humans are operator agents in their lives, not only seeing several brain mechanisms that are governed by environmental events. Sensory, motor and brain systems are tools used by humans to accomplish tasks and goals that give direction and meaning to their lives [43]. Humans are not autonomous agents or mechanical agents of environmental influence [44]. Human agency is the concept that students make deliberate decisions to invest in learning and make changes in behavior [45]. The core feature of an agency is its power to initiate actions for specific purposes. Social Cognitive Theory identifies three modes of human agency: personal, proxy, and collective [46].

2.6. Sample Size
Hypothesis testing using PLS-SEM doesn’t need normally distributed data, limited sample size, and can estimate parameters without goodness of fit [47]. In previous studies [48] using only 20 data correctly described PLS-SEM. The sample size in this study was representative for using the PLS-SEM method.

3. Methodology
The study runs on an empirical statistical scheme based on several similar studies previously related to the theories needed in this study. These theories include safety culture, factors / dimensions of safety culture, personality, personality types, social cognitive theory, and Structural Equation Modeling (SEM). The company examined in this study engaged in the chemical industry with a total production of 105,000 tons / year. The number of samples is 73 workers who work in the production area and workers who often do work in the field of factory. Data was collected by distributing questionnaires to respondents directly, the questionnaire consisted of 6 parts with 47 questions about the variables studied and a personality test with 50 questions. Likert scale is used to measure the answers to the questionnaire. Secondary data from the company is also used in this study. The relationship between variables is used as the basis for developing a conceptual model of the system. SmartPLS 3 is used in data processing by PLS-SEM method.

4. Result
Testing the structural equation modeling results using the PLS approach is done by looking at the results of the measurement model (outer model) and the results of the structural model (inner model) of the model under study.
4.1. Outer Model

In the first order reflective outer model that must be considered is the reliability test (outer loading and composite reliability) and the validity test (convergent validity and discriminant validity). Meanwhile, testing for the second order formative outer model is to see the colliniiarity and significance of the outer weight.

a. Reliability Test

Outer loading and composite reliability are used to find out which instrument items can be used as indicators of all latent variables. The results of this test are measured based on the outer loading value of the construct indicator. The reliability test will be fulfilled if the outer loading and composite reliability value of each indicator is > 0.7. The results obtained from the reliability test are that all indicators in this study have an outer loading value of more than 0.7 which indicates that the construct explains more than 50% of the indicator variance, this indicates that the indicator shows a satisfactory level of reliability.

Table 1. Composite reliability test results

| Indicator | Composite Reliability |
|-----------|-----------------------|
| A         | 0.978                 |
| C         | 0.977                 |
| E         | 0.979                 |
| N         | 0.981                 |
| O         | 0.978                 |
| SB        | 0.949                 |
| SA        | 0.970                 |
| ST        | 0.970                 |
| SE        | 0.984                 |
| SR        | 0.988                 |
| H         | 0.979                 |

Based on table 1, the results of composite reliability testing show that all latent variables are reliable because they have a composite reliability value greater than 0.7. The higher value indicating a higher level of reliability.

b. Validity Test

The validity test of the model is done by looking at the value of convergent validity and discriminant validity. The value in table 2 explains that the AVE value on the study variable has a value above 0.5, which means this measurement can be concluded that it qualifies the requirements for convergent validity measurement in measuring latent variables. Cross loading value from discriminant validity test results shows good discriminant validity because the cross-loading value of the intended construct is greater than other constructs which can also be interpreted that the correlation between an indicator with its latent variable is higher than the correlation with other latent variables, it predicts the indicator is better than other latent variables.

Table 2. Result of convergent validity test

| Indicator | AVE  |
|-----------|------|
| A         | 0.814|
| C         | 0.806|
| E         | 0.825|
| N         | 0.837|
VIF (Variance Inflation Factor) and outer weights values must be considered when analyzing the second-order model.

### Table 3. Result of VIF

| Variable            | Personality Traits | Safety Culture |
|---------------------|--------------------|----------------|
| Personality Traits  | 2.393              |                |
| Social Cognitive    | 1.000              | 2.393          |

Based on table 3 the VIF values < 5 explain there is no collinearity between latent variables. The significance of outer weight has been done by bootstrapping sample and the outer weight has been declared significant with a t-statistic value > 1.96, then the indicator must be maintained.

### 4.2. Inner Model

The Inner Model is a test on a structural model that is conducted to test the relationship between latent constructs. In this study the inner model testing is done by showing the value of $R^2$ in endogenous latent constructs. Furthermore, the structural model in the inner model is tested using predictive relevance ($Q^2$) values.

#### a. Coefficient of Determination (Test $R^2$)

Measuring the level of variation in the change of an independent variable to the dependent variable can use the value of $R^2$. The higher the value of $R^2$ means the better the prediction model from the proposed research model. Following are the results of $R^2$ obtained by using SmartPLS 3.0:

### Table 4. Coefficient of Determination (Test $R^2$)

| Variable           | Value of $R^2$ |
|--------------------|----------------|
| Personality Traits | 0.582          |
| Safety Culture     | 0.796          |

Based on table 4, the coefficient of determination, the value of R-Square personality traits shows that personality traits are influenced by social cognitive by 58.2%, while the remaining 41.8% is influenced by other factors that are not present in the model. Then the R-Square safety culture value was 0.796, meaning that the safety culture variable was affected by personality traits and social cognitive of 79.6%, while the remaining 20.4% was influenced by other factors outside the model.

#### b. Predictive - Relevance ($Q^2$)

A model is considered to have a relevant predictive value if the Q-square value is more than 0. Predictive value - relevance is obtained by the formula:

$$Q^2 = 1 - (1 - R1^2) (1 - R2^2) .... (1 - Rn^2)$$

$$Q^2 = 1 - (1 - 0.582) (1 - 0.796)$$

$$Q^2 = 0.915$$
The results of the Q-Square calculation in this study are 0.915, stated that the structural model is fit with the data, meaning that the research model is able to reflect the reality and phenomena in the field.

c. Analysis of Hypothesis Testing Results
Hypothesis testing is done by looking at the t-statistics measured by t-tables. Hypothesis testing in PLS is done by bootstrapping the sample with decision making criteria:
- Reject $H_0$ and accept $H_1$ if $t$-statistics > $t$-table (1.96)
- Accept $H_0$ and reject $H_1$ if $t$-statistics < $t$-table (1.96)

The results of calculations of the whole model using SmartPLS 3.0 are shows in Figure 1:

![Figure 1. T-value of second order construct](image)

**Table 5. Relationship between Personality Traits and Safety Culture**

| Constructive Relationship            | Path Coefficient | T Statistics | T-Table |
|--------------------------------------|------------------|--------------|---------|
| Personality Traits -> Safety Culture | 0.559            | 5.605        | 1.96    |

Based on table 5, the t-statistic value (5.605) is higher than the t-table value (1.96), meaning that $H_0$ is rejected and $H_1$ is accepted. Then the path coefficient is positive and concluded that personality traits are positively related to safety culture.

**Table 6. Relationship between Social Cognitive and Safety Culture**

| Constructive Relationship            | Path Coefficient | T Statistics | T-Table |
|--------------------------------------|------------------|--------------|---------|
| Social Cognitive -> Safety Culture   | 0.389            | 3.815        | 1.96    |

Based on table 6, the value of statistics (0.815) is higher than the value of table (1.96), meaning that $H_0$ is rejected and $H_1$ is accepted. Then the path coefficient is positive and concluded that social cognitive is positively related to personality traits.

**Table 7. Relationship between Social Cognitive and Personality Traits**

| Constructive Relationship            | Path Coefficient | T Statistics | T-Table |
|--------------------------------------|------------------|--------------|---------|
| Social Cognitive -> Personality Traits | 0.763            | 14.785       | 1.96    |
Based on the table 7, the value of statistics (14.785) is higher than the value of table (1.96), meaning that $H_0$ is rejected and $H_1$ is accepted. Then the path coefficient is positive and concluded that social cognitive is positively related to personality traits.

5. Discussion
The test results show that all three hypotheses accept $H_1$ and reject $H_0$, namely Hypothesis 1 with a t-value of 5.605, explaining that personality traits have a relationship with safety culture. This is consistent with research [50] which states awareness has a predictive influence on safety behaviour which is an indicator of safety culture. Conscientiousness type is the type that tends to act obediently and has high self-discipline, this type is very suitable for field workers in this study. Therefore workers in this company have high safety behavior, safety awareness, and safety attitudes, because as many as 35 workers have conscientiousness personality traits, and 38 other workers have personality traits of neuroticism, agreeableness, and openness which will be easier to direct to apply safety culture in the company. Meanwhile, a worker who has extraversion personality traits may find it difficult to be aware of the hazards in the company but because he prefers social activities which means he will follow his colleague's behavior to implement safety culture.

Hypothesis 2 with a t-value of 3.815, explain the relationship between social cognitive and safety culture is significant. This result is consistent with the results of previous studies [49] there is a relationship between safe behavior and self-efficacy. Having good self-efficacy/safety efficacy will increase safety behaviour among workers, because safety efficacy measures skills in avoiding and eliminating hazards in the workplace that will increase safety behaviour, safety awareness, and safety attitude which are important factors of safety culture.

Hypothesis 3 with a t-value of 14.785, explain the relationship between social cognitive and safety culture is significant. This is consistent with previous research which states that personality significantly interacts with social cognition to influence behaviour [35]. Social cognitive and personalities both have the power to control their thoughts, behavior, and emotions is controlled properly will be beneficial in enhancing safety culture. As an example of self-regulation here, it measures participation in company events, complies with regulations, and can adapt to new systems/techniques that develop in the company. Self-regulation matches the agreeableness personality type that tends to be obedient, caring, has an optimistic outlook, and often self-reported when an accident/near miss occurs at work.

6. Conclusion
In conclusion, personality traits, social cognitive, and safety culture are interrelated, therefore assigning someone to a job and making policies need to pay attention to one's personality and social cognitive in order to implement safety culture. Adhering to safety culture is beneficial in minimizing workplace accidents and even preventing it. Future research can increase the sample size and expand the area of research. Also, further research can consider other personality type variables besides the Five-Factor Model/Big Five Personalities.

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