The Survey on the Perception of Safety and Security Culture for Nuclear Workers

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Abstract. A survey was developed to evaluate employee perceptions of the safety culture and culture of nuclear security. The survey was made up of 52 questions divided into 13 factors: leadership, involvement of employee, work environment, employee competence, management commitment, procedures, leader attitude, training and qualifications, employee attitude, implementation and operation, integrated safety, self-assessment, belief. The survey was conducted on 125 employees working in nuclear area. A survey were conducted between February and May 2016. A numerical value was given to each question, so that the results of the survey were represented as a score. The data reveal that age group 60-69 years dominate by having the best perception on 6 factors. The overall value of factors, the company is included in rank B. The relationship between the long term period of working and to the value of rank does not show the relationship trend. MANOVA analysis showed that if multivariate test was done together, the thirteen factors did not show any differences on the group length of working. However, if analyzed individually, it turns out the Training and Qualification factors have different effects on the group of long term period of working.

Keywords: safety and security culture, nuclear security system, survey, questionnaires

1. Introduction

In a research, safety culture receiving more attention in industries including in nuclear power operations [1]. Even some examples of accidents where safety culture is identified as contributing to accidents, including BP’s Texas City Refinery Explosion in 2005 (The Chemical Safety Board, 2007), The Washington Metropolitan Area Transit Authority Rail Collision in 2009 (National Transportation Safety Board, 2010), The Deepwater Horizon Oil Spill in 2010 (United States Coast Guard, 2011), The Upper Big Branch Mine Explosion in 2010 (The Mine Safety and Health Administration, 2011), and The Fukushima Nuclear Accident in 2011 (National Diet of Japan, 2012) [1].

The Fukushima nuclear accident happened because of not understanding the security culture although the system has the sophisticated protection based on technology. Nuclear security culture consisting of series characteristics, attitude, and behaviors of individuals, organizations, and institutions that serve to support and enhance nuclear security [2]. The result of the most incidents nuclear is lack of awareness nuclear security culture and in addition, nuclear security culture became an important subject in the nuclear security summit at Hague with 53 countries as participants including Indonesia [3].

The relationship between security culture and safety culture is when the both consider the risk of human error, but nuclear security has an additional on deliberate action intended to cause harm [2]. The security requires different attitudes and behaviour such as confidentiality of information and the
prevention of malicious actions. The nuclear security culture refers to the dedication, accountability, and understanding of all individuals who involved in activities that have an influence on the security nuclear activities.

Measurements of safety culture were conducted using questionnaires. Similar with measurements of security culture also using questionnaires to surveys of personnel at nuclear power plant [4]. This is because a questionnaire survey is an effective way to test the level of awareness of nuclear security. The questionnaire that used to survey should cover all aspect of nuclear security. WINS (World Institute of Nuclear Security) publish of a simplied questionnaires but the questionnaires is not enough to analyse all of elements of nuclear security [4]. Several countries have developing questionnaire that reflect of all elements of their security culture.

ROK (nuclear power in South Korean) initiated a study to developing a questionnaire consisting of 20 questions of security nuclear culture in 2009 [4]. But besides South Korean, the number of countries that using nuclear security culture is not known yet. Indonesia has a questionnaire the safety culture that contained in the [5] for Implementation of Safety Culture.

The result of the literature study is indicating the existing questionnaire do not include all elements associated with the safety culture and security culture. It becomes necessary to develop a new survey tool be in the form questionnaire to evaluate the safety culture and the security culture. A survey examining awareness of safety and security culture in nuclear area with developing questionnaire.

2. Methods

2.1 Basic Theory

2.1.1 Safety Culture. The first appeared term of safety culture is in the OECD Nuclear agency Report of 1987 which published in INSAG of the year 1988 because of accident from Chernobyl in 1986 [6]. Later on, this term accepted as a culture where safety issues is top priority in the company.

Utal (1983) says that the definition of safety culture is a part of a trust and a value which integrated with control system and organizational structure that constitute behavioural norms [7]. Safety culture is a combination of characteristics and attitude within organization and individuals that establish as a top priority [8]. Besides that, safety culture is a part of the organizational culture which can influence attitude of members who can believe in safety and health performance [6].

2.1.2 Security Culture. Security culture is a set of characteristics, attitude, and behaviours of individuals, organizations and institutions can support and enhance nuclear security [2]. The nuclear security aims to ensure that implementation of security nuclear receives a certain amount.

2.1.3 The relationship Safety and Security Culture. The nuclear safety is the achievement of appropriate operating conditions, accident prevention, or mitigation of consequence of accidents, which may affect in the protection of workers, society, and the environment from undue radiation [9]. The security in nuclear is prevention and detection, responding theft, sabotage, unauthorized access, illegal transfer, or other malicious acts involving nuclear material, other radioactive substances or facilities related [9]. Between safety and security are built upon the legal and regulatory framework, the framework should define the responsibilities of the state, government regulations, and operators.

2.2 Research Method

2.2.1 Developing Questionnaire. Factor affecting security and safety nuclear was derived from 11 literature review on the safety measurement, security culture/climate, and guidelines about safety and security culture/climate in nuclear area. The literature is used for getting the most factor that commonly used. The literature about safety take from guideline (international safety advisor group) [8], assessing
safety culture in nuclear engineering laboratory [10], identifying the common features (measuring safety climate such as in nuclear industries, nuclear power plant, 23 energy industries in England) [11], guidelines from OHSAS [12], SCART guidelines [13], the factors which take effect occupational health and safety in radiology area and in a company [7] [14]. The literature about security take from nuclear security series [2] and survey on personnel at nuclear power plants [4].

2.2.2 The Questionnaire. The result of research, the number of factors is 13 factors that influence safety and security culture in the nuclear area [15]. The answer to the questions fall into five categories: strongly disagree, disagree, neutral, agree, and strongly agree.

2.2.3 The 13’s Factor

- Leadership
  This factor consists of 10 questions. These questions include organization, compliance, acknowledgment, command and direction, involvement, acceptance of suggestions and inputs, policies, responsibilities, and procedures related to the safety culture and culture of nuclear security.

- Involvement of Employee
  This factor consists of 4 questions. These four questions include discussion, and active involvement by workers.

- Work environment
  This factor consists of 6 questions. The six questions related to the safety culture and culture of nuclear security are policy transparency, organizational performance measurement, performance indicators, convenience and facilities provided.

- Employee competence
  Questions that fall into this factor are related to support, examples from leadership, training, competence, evaluation, emergency response systems, and reporting media. Questions on this factor amounted to 7 pieces.

- Commitment of management
  The number of questions on this factor consists of 2 pieces. The question is related to coordination and task assignment, roles and responsibilities to improve nuclear safety and security.

- Procedures
  This factor consists of 4 questions. The four questions relate to easy to find work procedures, existing procedures covering all systems at all levels of the organization, procedures for retention of outdated procedures, roles and responsibilities for procedures.

- Leaders attitude
  The number of questions on this factor there are 4 pieces. these four questions are related to the evaluation of the leader, the support of employees, the lack of awareness, and a good example of understanding and knowledge about safety and security risks.

- Training and qualifications
  The question on this factor consists of 2 questions. The question involves a medical examination, and the principle of nuclear security is as important as nuclear safety.

- Workers attitude
  This factor has 2 questions. These questions include workers' compliance with requirements and procedures and objectives and targets to be achieved according to the procedure.

- Implementation and operation
  Questions on this factor amounted to 3 pieces. these questions include the training schedule of the organization, the organization's evaluation of an event, the ease of understanding the guidelines or procedures.

- Integrated of safety
Factor include the presence of a committee for safety and nuclear security and activeness leader to finding the root of the problem.

- Self assessment
  The number of questions on this factor there are 3 pieces. Questions on these factors relate to self-learning of self-errors or co-workers, occupational safety and security concerns, and workers and co-workers remind each other about the procedures.

- Belief
  This factor consists of 3 questions. Existing questions relate to the belief that every worker has an important role in safeguarding or strengthening nuclear safety and security in the organization. Existing questions also include belief in threats that can come from within and outside the country. In addition, there are also questions related to regular emergency response exercises.

**Table 1. The Question in Leadership Factor**

| No | Questions                                                                 | S. | D | D | N | A | S.A |
|----|---------------------------------------------------------------------------|----|---|---|---|---|-----|
| 1  | Organizations always planning the good procedures including handling     |    |   |   |   |   |     |
|    | prevention and incident                                                  |    |   |   |   |   |     |
| 2  | Organizations always evaluate compliance with regulations concerning     |    |   |   |   |   |     |
|    | nuclear safety and security both within and outside the country          |    |   |   |   |   |     |
| 3  | Leaders provide recognition and rewards to employees who trying to       |    |   |   |   |   |     |
|    | improve nuclear safety and security                                      |    |   |   |   |   |     |
| 4  | Leaders provide the orders and direction for employees to raising        |    |   |   |   |   |     |
|    | awareness and behavior toward safety and security                        |    |   |   |   |   |     |

3. Result and Discussion

This survey was conducted in February 2016 - May 2016. Respondents who fill out the questionnaire are required to had attended Radiation Protection Training for New Employees as the basic of Occupational Health and Safety knowledge. A total of questionnaires is 125 but the questionnaire which met requirements for processing is 77 questionnaires.

To compare the survey result before February 2016 was conducted in 2014. The result declare that the employee has Score C and the questionnaire which that used not cover the security culture.

3.1. Scoring Age by Group

The results of each age associated with their point of views on each factor that have different values. The value is taken from the mean value in each age group. The answer strongly disagree has a value of 1, disagree has a value of 2, neutral has a value of 3, agree has a value of 4, strongly agree has a value of 5.

Figure 1 explains that for the age group 30-39 years old have the best perception of self-assessment factors, and training and qualifications. The 40-49 years old has the best perceptions of beliefs, employee competencies, and procedures. The 50-59 years old have the best perception of commitment of management, and implementation and operation. The 60-69 years old have the best perceptions of worker involvement factors, work environment, leader attitude, worker attitude, integrated safety and leadership. The age group 60-69 years dominates by having the best perception on 6 factors. In Figure 1 it is explained that the number of samples (n) for each age group has different amounts.
3.2 Overview by Grade

The index level is determined on the difference of the highest value of 5 and the lowest value is 1 of the likert scale, then divided into 5 assessment scales as in Table 2. This index level is useful to know the general description of the application of safety culture and security in an organization.

Table 2. The Grade

| Grade | Indeks |
|-------|--------|
| A     | ≥4,2   |
| B     | 3,4 ≤ X < 4,2 |
| C     | 2,6 ≤ X < 3,4 |
| D     | 1,8 ≤ X < 2,6 |
| E     | < 1,8  |

The average score on the employee perception level based on the index level for each factor is ranked B except the Training and Qualification factors which score 4.54 (rank A). The overall score is at 4.08 index in rank B.

3.3 Analysis the relationship of Long Term Period of Working to perception value

The regression to analysis of the relationship is shown equation model could not be used to see the actual condition. The result of significance does not show the trend of relationship between the the long term period of working with value. When viewed from the analysis, the relationship between the long term period of working with the value score of employee perceptions could not be modeled into an equation because it has no relationship trend. This is similarly to [4] research.

3.4 Analysis the influence of Long Term Period of Working to Value

The conclusions from the MANOVA analysis (dependent variable is the long time period of working, and independent variable is the 13 factors) were that if the multivariate test were conducted together, the thirteen factors did not show differences in the period length of working group (Multivariate test has sig. >0.05). However, if analyzed individually, it turns out the Training and Qualification factors have
different effects on the period length of working group. Because all of Factors has sig. > 0.05, except Training and Qualification which has sig. 0.047. Based on the analysis, the perception of Training and Qualification factors at the company have different effect because longer the long term period of working make the training and the qualifications will also change. That will change the qualification from the employee.

4. Conclusion
The questionnaire consisted of 13 factors, leadership, employee involvement, work environment, employee competence, management commitment, procedures, leader attitude, training and qualifications, workers attitude, application and operation, integrated safety, self-assessment, confidence. A total of 125 people working in the nuclear agency/company/institution were surveyed. The level of perception of a culture of nuclear safety and security is expressed numerically.

Scoring age by group has the result is the ages of 20 - 29 years as the youngest age group have not had a prominent perception for nuclear safety and security culture. The age group 60 - 69 years old dominates by having the best perception on 6 factors.

The average score on the employee perception level based on the index level for each factor is ranked B except the Training and Qualification factors which score 4.54 (rank A). The overall score is at 4.08 index in rank B.

The conclusions from the MANOVA analysis were that if the multivariate test were conducted together, the thirteen factors did not show differences in the length working group. However, if analyzed individually, it turns out the Training and Qualification factors have different effects on the period length working group.

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