Preliminary Study on Safety Culture of the Nuclear Regulatory Body in the Philippines

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1. Introduction

The concept of safety culture started after the Chernobyl nuclear accident in 1986. Although safety culture may be defined differently by various research, the International Atomic Energy Agency (IAEA) defined it as "the assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance" [1,2]. Therefore, safety culture simply encompasses the behaviors of individuals and organizations to address safety concerns in the workplace.

The nuclear operating organization was initially regarded as the main concern in the safety culture issues while the regulatory body was responsible in development and implementation of methods for oversight of safety culture of the licensees. However, after Fukushima Daiichi nuclear accident in 2011, the perception on the importance of safety culture within regulatory bodies changed. With this, significant studies on safety culture competences and self-assessment methods for the regulatory body were also given attention [2]. The regulatory body has an extensive role in safety goals, oversight, and ensuring protection of the people and the environment from harmful effects of radiation.

For a nuclear embarking country like Philippines, it is important to establish a strong safety culture from pre-operational phase for a successful nuclear power program. The regulatory body needs to provide oversight at all phases, from pre-operation to decommissioning, and to establish its own safety culture to influence the licensees. Safety culture assessment in pre-operational phase allows the organization to reach a common understanding of the concept of safety culture and to develop strategies for improvement [3].

The Philippine Nuclear Research Institute (PNRI) has the primary authority in licensing and regulating atomic energy facilities and materials, and to promote the peaceful use of atomic energy, as enacted in the Republic Act No. 5207. Currently, the PNRI regulates a total of 447 licensees for radioactive and nuclear materials distributed in different applications as shown in Fig. 1.

Although the PNRI has dual mandate, this study mainly focuses on preliminary assessment of safety culture of the PNRI's regulatory function under the Nuclear Regulatory Division (NRD).
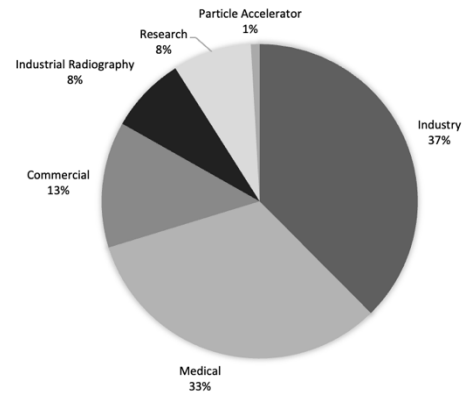

Fig. 1. Licensee distribution in different fields

2. Methodology

The preliminary assessment was conducted through quantitative survey method among the employees of the regulatory body. The Microsoft forms platform was used to host the online survey and invitations were distributed through email. The questionnaire, composed of 71 elements, was adopted from the 11-dimension safety culture concepts developed by the IAEA safety culture working group [4]. Each element on the questionnaire was rated on a 5-point Likert scale that evaluates the respondent's level of agreement to the statement in which a 5 represents strongly agree while a 1 represents strongly disagree. The responses were recorded anonymously to encourage the employees to express their opinions without the fear of being reprimanded.

The results were analyzed using SPSS version 28. It was also evaluated in comparison with the safety culture principles identified by IAEA. While self-assessment is less objective, it is more adaptable, and it offers learning opportunities for individuals and the institute.

3. Results and Discussion

3.1. Perception survey analysis

The results were generated from the survey among employees of the regulatory body at different levels: management, senior specialist, mid-level specialist, entry-level technical staff, and administrative and support staff as presented in Fig. 2.
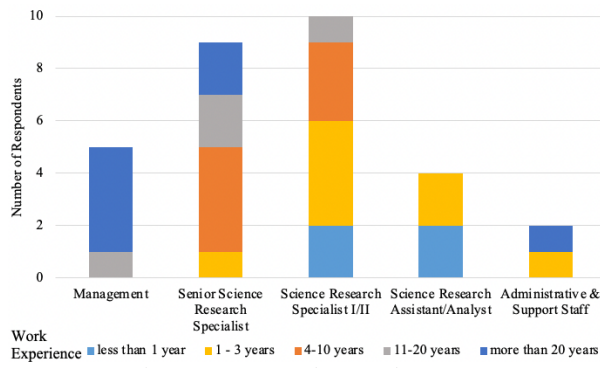
Fig. 2. Summary of respondents

The response rate was 94%, composed of 31 among 33 employees from the regulatory body. The required minimum number of respondents was calculated using Slovin's Formula of sample size determination, given a 95% confidence level and a 5% margin of error.

Slovin's Formula:

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

where,
n: sample size
N: population
E: margin of error

$$n = \frac{33}{1 + (33 \times 0.05^2)} = 30.48$$

The descriptive statistics of 71 elements were summarized in Table I. The strengths and weaknesses related to safety culture of NRD were identified from the results of the survey. Generally, the results revealed that the respondents had positive perceptions towards the safety culture given that all elements under different dimensions had a mean of greater than 3. Specifically, the mean for each dimension were: 4.13 for systematic regulatory approach, 4.00 for learning, improvement, and competence, 3.99 for responsibility and accountability, 3.96 for both leadership and decision making, 3.92 for interdisciplinary and internal cooperation, 3.91 for questioning attitude, 3.85 for openness, transparency, and external cooperation, 3.80 for independence of the regulator, 3.72 for ethics and moral courage, and 3.52 for psychological safety.

The respondents were most positive about their leaders being role models to promote safety culture (M, 4.35). This element was relatively influenced by the work experience of the management. Fig. 2 showed that majority of the management has more than 20 years of experience as a regulator. IAEA Safety Standards GSR Part 2, Requirement 2, is explicit that leadership is one of the key factors to foster strong safety culture in an organization [5]. Moreover, good perception on the cooperation with licensees (M, 4.26), competence in fulfilling responsibilities, learning from relevant organizations and consistent high expectations for safety (M, 4.19) were observed.

Respondents were less likely to agree that: there is no intimidation and conflicts can be resolve practically (M, 3.45), resources are sufficient (M, 3.48), there is easiness to raise concerns, and there is high level of trust between management and staff (M, 3.50). In general, respondents were less likely to agree on elements under psychological safety, and ethics and moral courage. Although there is a satisfaction for the leaders being role models for safety, a mentoring or coaching program with the staff can be established to build connection and improve their communication and conflict-resolution skills. The institute can also develop a communication tool in raising safety concerns to increase transparency and provide assurance to the staff that issues are evaluated and addressed properly.

3.2. Reliability test

Reliability test is important to check the extent in which the group of statements are related. In this study, the internal consistency of the 71 elements included in the questionnaire is measured using Cronbach's Alpha (α). It is considered reliable if the Cronbach's Alpha value is greater than 0.7. Therefore, the Cronbach's Alpha shown in Table I indicates that the 11-dimension survey result is reliable.

Table I: Statistics for 11-dimension elements

Dimension	Element	Mean (M)	Standard Deviation (SD)
A. Leadership (α = 0.937)	Leaders behave as role models for a positive safety culture	4.35	0.88
	NRD management takes clear responsibility for their own actions and errors	3.84	0.82
	Senior managers foster a positive safety culture within our organization	3.84	0.93
	NRD management is responsive to concerns	3.74	0.97
	My supervisor treats staff fairly	3.97	1.08
	NRD management demonstrates that people are valued	3.84	1.04
	Senior managers ensure that protection of people and environment is above all other priorities	4.13	0.99
	NRD management encourages open discussion	3.94	1.00
B. Psychological Safety (α = 0.941)	People feel free to raise concerns, without fear of retaliation	3.55	1.21
	All employees are treated with respect	3.65	1.05
	NRD is free of intimidation	3.45	0.96
	There is a high level of trust between NRD management and staff	3.52	1.03

Dimension	Element	Mean (M)	Standard Deviation (SD)
	We resolve conflicts constructively	3.45	1.03
C. Learning, Improvement and Competence ($\alpha = 0.943$)	People are competent to fulfill their responsibilities	4.19	0.70
	In our organization, people receive the training they need	3.77	0.81
	NRD management has a clear understanding of the competencies required for our work	3.94	0.89
	NRD management takes actions based on the results of assessments/audits	3.84	0.93
	We learn from our own past experiences	3.87	1.02
	NRD is competent in doing its job	4.00	0.82
	The results of assessments/audits of our organization are communicated to us	4.03	0.95
	Continuous improvement is a part of the way we work	4.13	0.85
	We welcome assessment by outside organizations	4.06	0.85
	We keep up to date with new developments in our field of work	4.03	0.71
	We learn from other relevant organizations	4.19	0.70
D. Openness, Transparency, External Cooperation and Communication ($\alpha = 0.949$)	Safety significant issues are communicated appropriately throughout the organization	3.87	0.81
	I can trust the management to share information	3.77	0.76
	NRD addresses safety concerns openly	3.94	0.77
	We listen to concerns from the public and interested parties	4.00	0.82
	Information is effectively communicated across teams	3.65	0.99
	I can trust my colleagues to share information	3.77	0.92
	Safety decisions are communicated to the relevant parties	3.94	0.81
E. Ethics and Moral Courage ($\alpha = 0.937$)	Leaders display the highest ethical standards	3.68	1.01
	It is easy to raise ethical concerns without fear of retaliation	3.52	1.03
	Employees who insist on high safety standards are valued	3.77	0.88
	Leaders take action when they become aware of ethical issues	3.77	0.85
	We are fair in our oversight activities	3.87	0.85

Dimension	Element	Mean (M)	Standard Deviation (SD)
F. Independence of the Regulator ($\alpha = 0.875$)	We have easy access to information	3.90	0.91
	We have sufficient resources to fulfill our mission	3.48	0.85
	NRD makes decisions independent of undue political influence	3.77	0.99
	The government respects our decisions concerning safety	3.94	0.81
	We are given enough authority to perform our work without interference	3.90	0.87
G. Responsibility and Accountability ($\alpha = 0.975$)	Roles and responsibilities are clearly assigned	3.94	0.89
	People take responsibility for their assigned tasks	4.03	0.88
	People are held accountable for their work	4.00	0.93
H. Systematic Regulatory Approach ($\alpha = 0.966$)	We consider the broad safety implications of our actions	4.06	0.81
	We never compromise licensee responsibility for safety	4.16	0.69
	We cooperate with licensees to continuously improve safety	4.26	0.73
	We positively influence licensee safety culture	4.03	0.91
	We have consistently high expectations for safety	4.19	0.65
	We listen to licensee concerns	4.16	0.74
	We act as role models for the licensee safety culture	4.06	0.89
I. Decision Making ($\alpha = 0.966$)	When a decision turns out to be wrong, the decision is revised	3.84	0.78
	Safety is the overriding priority when decisions are made	4.06	0.73
	The basis for decisions is documented	4.03	0.84
	Authority for decision-making is clear	3.94	0.81
	The level of risk is considered when making decisions	4.00	0.86
	Decisions are based upon relevant information	4.06	0.81
	Decisions are made within an appropriate time-frame	3.77	0.99
J. Questioning Attitude ($\alpha = 0.980$)	People feel free to report errors	3.84	0.97
	We actively seek different perspectives	3.94	0.96
	All safety related matters can be questioned	4.00	0.97

Dimension	Element	Mean (M)	Standard Deviation (SD)
	Everyone's input is valued	3.84	1.00
	The organization is careful to avoid complacency	3.84	0.97
	When things are unclear, we seek clarity before proceeding with the task	3.97	0.95
K. Interdisciplinary, Internal Cooperation (α = 0.947)	People are willing to share their expertise	4.00	0.97
	NRD respects diversity of expertise	3.97	0.98
	There is high level of trust between NRD sections	3.58	0.99
	There is a high level of trust within our section	4.10	0.98
	People value each other's opinion	3.84	0.97
	NRD promotes teamwork	4.00	1.00
	Working conditions are good at our workplace	3.94	0.96

3.3. Safety culture models

Most organizations follow the IAEA and OECD-NEA safety culture models. Although each safety culture framework has its own characteristics, there is still an overlying principle between these two models such as the safety values, leadership, accountability, and learning [1,2]. The 71 elements were also analyzed in relation with the IAEA 5 safety culture principles as shown in Table II. Each principle also has good internal consistency.

Table II: Mean and Cronbach's Alpha for each IAEA principle

IAEA	Mean (M)	Cronbach's Alpha
1. Safety is a clearly recognized value	4.02	0.980
2. Leadership for safety is clear	3.87	0.950
3. Accountability for safety is clear	3.99	0.956
4. Safety is integrated into all activities	3.78	0.978
5. Safety is learning driven	3.97	0.970

Principle 4 got the lowest mean overall. This was greatly affected by the low perception on psychological safety dimension. In contrast, principle 1, having the most positive perception, indicates that the organization has comprehensive and systematic approach to safety. The institute can also consider the implementation of integrated management system to continuously improve this area. Although there are areas for improvement to achieve holistic safety culture maturity level, the organization generally has a positive safety culture. (M, 3.93).

4. Conclusion

Safety culture assessment requires commitment from the management and the whole organization. In this study, the preliminary result of assessment provides insight of the regulatory body on safety culture of their organization. In general, employees had positive perceptions on the organization and common practices. However, there is a need to address the identified weaknesses such as building trust between management and staff, promoting open communication, and improving ethics and moral courage. This result can be considered in establishing safety culture principles as part of the integrated management system that is suitable for the institute.

Further assessments by conducting focus group discussions, interviews, document reviews, observations, team findings or additional surveys can be carried out for a substantial and more realistic perspective on safety culture of the organization. Combination of different methods can provide assurance that the result comes from a broader perspective.

Acknowledgement

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