

Limitations in the Application of Nuclear Safety Culture in the Korean Context

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***Keywords :** safety culture, Korean context, safety compliance code, accountability

1. Introduction

The concept of “safety culture” has become a cornerstone of nuclear safety, emphasizing that technical systems alone cannot ensure reliability without the active role of human behavior and organizational integrity. Since the Chernobyl accident in 1986, international bodies such as the IAEA, INPO, and WANO have refined the notion of safety culture into measurable traits, including leadership commitment, accountability, and continuous learning, and have integrated these traits into evaluation and peer review processes. Globally, safety culture has thus evolved into a normative framework supported by practical standards and observable behaviors.

In the Korean context, however, the term “culture” carries connotations of voluntariness, atmosphere, or shared lifestyle rather than obligation. This semantic and cultural nuance creates a conceptual gap when combined with “safety,” which is inherently compulsory and legally binding. Consequently, safety culture in Korea often remains symbolic—expressed through posters, slogans, and campaigns—rather than functioning as an enforceable operational principle. This paper argues that to ensure nuclear safety in Korea, it is necessary to move beyond abstract cultural ideals and develop a more practical and action-oriented framework. To this end, it proposes the “Safety Compliance Code,” a behavior-based, enforceable model designed to bridge the gap between values and practice while aligning with Korea’s regulatory and social environment.

2. Methods

A qualitative research design was used three stages : literature review, comparative analysis, and conceptual framework development to explore the limitations of applying “safety culture” in Korea and to propose the “Safety Compliance Code” as a more practical alternative.

2.1 Literature Review

A systematic review of foundational documents was conducted, including the IAEA’s *INSAG-4* (1991), *TECDOC-1329* (2002), and the *Harmonized Safety Culture Model* (2020), as well as INPO’s *Principles for a Strong Nuclear Safety Culture* (2004) and WANO’s *Traits of a Healthy Nuclear Safety Culture* (2013).

These materials provided the definitional basis, key traits, and implementation mechanisms of nuclear safety culture. In addition, OECD/NEA reports and country-specific studies (e.g., Canada, Japan, Sweden) were analyzed to capture how cultural and institutional contexts influence organizational behavior and safety outcomes.

2.2 Comparative Analysis

The study then contrasted international definitions and practices of safety culture with their application in Korea. Particular attention was given to the semantic and cultural distinction whereby “culture” in Korea tends to imply voluntariness or atmosphere, whereas “safety” denotes enforceable, legally binding standards. Comparative references were drawn from international cases such as Canada’s enforceable frameworks and the UAE’s Barakah Nuclear Power Plant, highlighting differences in organizational hierarchy, leadership responsibility, and adaptability to international norms.

2.3 Conceptual Framework Development

Finally, insights from the literature review and comparative analysis were synthesized into the development of the “Safety Compliance Code.” This framework transforms abstract cultural values into codified behavioral standards, clarifies roles and responsibilities, and incorporates accountability mechanisms through monitoring, evaluation, and enforcement. The framework was designed to integrate international best practices while adapting them to the regulatory, cultural, and institutional characteristics of Korea, ensuring both contextual relevance and operational feasibility.

Through this methodological process, the study bridges theoretical perspectives with practical considerations, establishing a robust foundation for redefining nuclear safety management in the Korean context.

3. Results

This section analyzed the limitations of the safety culture concept within the Korean context and identified the need for a new framework that ensures both enforceability and practical effectiveness. The findings are presented in three main dimensions.

3.1 Conceptual Incompatibility Between “Safety” and “Culture”

The first finding highlights the semantic gap between the concepts of “safety” and “culture.” In Korea, the term *culture* is generally associated with voluntary, emotional, and lifestyle-related practices, such as food culture, drinking culture, or corporate culture. Popular perceptions also connect culture to symbolic images like K-pop, traditional hanok houses, and hanbok attire, evoking an aesthetic or identity-based dimension rather than a normative one. Thus, *culture* is often understood as a shared atmosphere or optional practice rather than a compulsory standard.

By contrast, *safety* has emerged as a core societal value in Korea, representing non-negotiable rules that must be observed by everyone. Safety is directly linked to the protection of human life and codified through legal frameworks such as the Industrial Safety and Health Act, the Serious Accident Punishment Act, and the Nuclear Safety Act. Violations entail administrative sanctions or even criminal penalties. Therefore, safety constitutes an absolute normative obligation rather than a matter of personal choice.

This divergence creates a conceptual incompatibility: while *culture* implies autonomy and flexibility, *safety* embodies compulsion and legal enforceability. Consequently, the term *safety culture* risks diluting the normative force of safety, rendering it a vague or symbolic notion. When safety is framed as a “culture,” it may be perceived as discretionary rather than mandatory, reducing its practical impact. This undermines efforts to embed safety as a behavioral standard in practice, leaving it at the level of slogans or campaigns.

3.2 Organizational and Structural Constraints

The second finding concerns organizational and structural constraints that impede the institutionalization of safety culture in Korea. Korean organizational environments are characterized by hierarchical structures, authority-centered decision-making, and a reluctance to raise issues. In such settings, internationally promoted principles—such as a questioning attitude, open communication, and mutual accountability—are difficult to internalize. Social discomfort with questioning or open dialogue further limits opportunities for proactive safety engagement.

Under these conditions, voluntary adherence to safety culture proves insufficient. Instead, explicit regulatory mechanisms are required to ensure that questioning, communication, and accountability are systematically reinforced. Rules must be established such that non-compliance constitutes a formal violation of organizational policies. Furthermore, given the difficulty of overcoming these cultural and structural barriers in the short term, this study suggests considering the deployment of independent safety

observers. These third-party monitors would oversee compliance with nuclear safety standards and provide impartial oversight. Such external mechanisms could help compensate for internal cultural limitations and enhance the effectiveness of safety implementation.

3.3 Proposal for a Safety Compliance Code

This section proposes the introduction of a behavior-based Safety Compliance Code that secures both enforceability and practicability, in contrast to the traditional notion of “safety culture.” While the term “culture” often implies voluntary or discretionary behaviors, the concept of a “code” entails normative obligations that must be observed without exception. Therefore, safety must be reframed not merely as a value to be aspired to, but as an institutional and behavioral duty that all organizational members are required to follow:

- *Clarification of roles and responsibilities* - The starting point of the Safety Compliance Code is the clear delineation of individual roles and responsibilities. In Korean organizational settings, accountability often becomes diffused or absorbed into collective structures, making it difficult to assign responsibility in practice. To prevent this, job descriptions, regulations, and manuals must explicitly define safety-related duties, with special emphasis on leadership accountability. Leaders should not only function as symbolic figures but must also bear ultimate responsibility for safety outcomes, with direct accountability in cases of regulatory violation or accidents.
- *Standardization of procedures and guidelines* - For safety to operate as a binding rule, ambiguity must be eliminated and procedures must be consistently applicable across all contexts. To this end, standard operating procedures (SOPs) should be developed by integrating international norms (e.g., IAEA Safety Standards, WANO Guidelines) with domestic regulations. These SOPs must be further specified into detailed work instructions, ensuring that organizational behavior is guided primarily by institutional rules rather than individual discretion.
- *Leadership accountability and performance monitoring* - The Safety Compliance Code positions leaders as active executors of safety, rather than symbolic figures. Leaders are required to supervise compliance, conduct regular monitoring, and integrate safety performance into evaluation and reward systems. This structural linkage compels leaders to treat safety compliance as a key operational metric, thereby strengthening the practical influence of safety codes within organizational processes.
- *Deployment of independent observers* - Given the hierarchical and communication-constrained

features of Korean organizations, there is a risk that safety rules remain only formalistic. To mitigate this, it may be effective to deploy independent third-party safety observers for a defined period. Such observers, vested with the authority to identify and report noncompliance, can provide external oversight that compensates for internal communication barriers. This mechanism ensures that compliance is not only formally declared but substantively enforced in practice.

- *Execution Mechanisms and Feedback Systems* - The Safety Compliance Code must function as a continuous learning system rather than a one-time regulatory initiative. This requires the institutionalization of feedback loops that collect implementation issues, integrate them into policy revisions, and rapidly address identified deficiencies. Feedback systems should involve all levels—observers, leaders, and members—through structured reporting channels and regular review meetings to ensure the code’s adaptability and effectiveness.
- *Sustainable Implementation Strategies* - For the Safety Compliance Code to achieve long-term institutionalization, supplementary mechanisms such as training, education, and incentive systems are essential. In the initial stage, compliance should be reinforced through sanctions for violations to secure enforceability. Over time, however, the emphasis should gradually shift toward autonomy and accountability, enabling safety compliance to become internalized as a shared organizational value. Reward systems that acknowledge exemplary adherence and regular training programs to foster habitual safe behavior are critical to this transition.

The introduction of a behavior-based Safety Compliance Code represents a strategic shift from safety as an optional value to safety as a mandatory norm. In the Korean context, the concept of “culture” risks being perceived as discretionary, whereas a “code” carries the binding force of regulation. By establishing compulsory mechanisms, third-party oversight, and continuous monitoring, the code ensures practical enforceability in its early stages. Subsequently, it can be evolved into a framework emphasizing self-regulation, shared accountability, and organizational learning. Such an approach is expected to transform nuclear safety from a discursive ideal into a concrete and enforceable behavioral system, thereby contributing to the strengthening of nuclear safety practices at both organizational and national levels.

4. Discussion

This section explored the limitations of applying the concept of “safety culture” within the Korean context and proposed the introduction of a behavior-based

Safety Compliance Code as a more effective framework. While the findings revealed both conceptual and organizational barriers, the implications extend beyond Korea and offer insights for the broader international discourse on nuclear safety.

4.1 Positioning within International Safety Culture Frameworks

International organizations such as the IAEA, WANO, and INPO have long emphasized safety culture as a cornerstone of nuclear safety. Their frameworks highlight leadership, questioning attitudes, open communication, and organizational learning as essential traits. These models generally assume that “culture” itself carries normative force, shaping behaviors even without explicit regulation. However, in Korea, the term “culture” is often perceived as symbolic or voluntary rather than compulsory. When combined with “safety,” it risks diluting the normative obligation to follow safety rules.

The proposed Safety Compliance Code seeks to address this contextual misalignment. It does not reject international frameworks but instead complements them by embedding enforceable behavioral rules into organizational practice. This approach is particularly relevant where the cultural perception of “culture” weakens compliance with safety expectations.

4.2 Addressing Organizational Constraints

One of the critical findings of this study is that hierarchical and authority-centered structures remain deeply entrenched, limiting open communication and mutual accountability. While international models emphasize trust, transparency, and shared responsibility, these values require a receptive organizational environment. In Korea, however, questioning a superior is often perceived as disruptive rather than constructive.

The Safety Compliance Code offers a corrective mechanism by converting cultural ideals—such as responsibility and openness—into observable, enforceable, and auditable actions. In doing so, it ensures that safety is reinforced through both cultural values and formal compliance mechanisms, thereby creating a dual pathway for achieving reliability in high-risk operations.

4.3 The Role of Independent Safety Observers

Another notable consideration is the role of independent safety observers. The deployment of third-party monitors serves as a safeguard to ensure that declared commitments to safety are effectively implemented in practice. While this mechanism is not explicitly emphasized in international safety culture frameworks, it can serve as a transitional tool in environments where organizational inertia slows cultural transformation. Moreover, the use of external oversight aligns with global trends in nuclear safety

governance that emphasize transparency, external review, and peer evaluation.

4.4 Broader Applicability and Scholarly Contribution

Although this study is centered on Korea, the findings contribute to global discussions on the contextual application of safety culture. High-reliability industries often face challenges when abstract cultural values fail to translate into concrete actions without clear enforcement mechanisms. The Korean case illustrates the risk of conceptual dilution and underscores the need for an integrated approach that combines cultural aspirations with compliance-based systems.

The Safety Compliance Code thus provides a model that may be relevant for other countries or organizations characterized by legalistic traditions or hierarchical cultures. By presenting compliance as a bridge between cultural ideals and operational realities, this study enriches the ongoing debate on how safety culture is operationalized and sustained across diverse contexts.

5. Conclusion

This study critically examined the limitations of applying the concept of *safety culture* within the Korean nuclear context and proposed the adoption of a behavior-based Safety Compliance Code as a more effective and context-sensitive alternative. The findings indicate that while international frameworks such as those of the IAEA, WANO, and INPO emphasize leadership, communication, and organizational learning, the symbolic and selective interpretation of “culture” in Korea undermines their practical enforceability.

By reframing safety expectations into a compliance-oriented framework, this study highlights the necessity of enforceability and accountability as central to nuclear safety. The proposed Safety Compliance Code provides a structured approach by clarifying roles and responsibilities, standardizing procedures and guidelines, and establishing monitoring mechanisms, including independent oversight. These measures ensure that safety is not merely a cultural aspiration but a non-negotiable behavioral standard, thereby strengthening the reliability of high-risk organizations.

Furthermore, the study underscores that overcoming organizational and structural constraints—such as hierarchical decision-making and communication barriers in Korea—requires more than cultural change. Regulatory and procedural reinforcements are indispensable. Recognizing the limitations of voluntary commitment, this research emphasizes the need to institutionalize safety as an absolute obligation directly linked to human life.

The contribution of this study extends beyond Korea. In countries with similar hierarchical or rule-based traditions, a hybrid approach that combines cultural values with compliance-based mechanisms may prove

effective. Thus, the research enriches nuclear safety discourse by offering a model that contextualizes international principles to fit national realities.

In conclusion, ensuring nuclear safety demands both cultural commitment and behavioral enforceability. The proposed Safety Compliance Code represents a practical tool to achieve this balance, contributing to stronger safety governance not only in Korea but also in other nuclear-operating nations worldwide.

This research was supported by the 2025 Research Fund of the KEPSCO International Nuclear Graduate School (KINGS), the Republic of Korea.

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