Analysis of Nuclear Safety Culture and Executive Leadership Strategy for Emerging Nuclear Nations: The Case of Türkiye

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***Keywords:** nuclear safety culture, IAEA, leadership, Akkuyu NPP, Türkiye, safety management

1. Introduction

Nuclear safety culture has become one of the most important aspects of nuclear power plant operation following lessons learned from major nuclear accidents worldwide. International organizations such as the International Atomic Energy Agency (IAEA), the Institute of Nuclear Power Operations (INPO), and the World Association of Nuclear Operators (WANO) emphasize that safety culture must receive the highest organizational priority.

Türkiye is currently developing its first commercial nuclear power plant through the Akkuyu Nuclear Power Plant (NPP) project. In parallel with infrastructure development, the country has established the Nuclear Regulatory Authority (NDK), expanded international cooperation, and invested significantly in workforce development. These initiatives have created a strong institutional foundation for nuclear safety.

Despite these achievements, Türkiye remains a newcomer nuclear nation with limited domestic operating experience. Therefore, continuous evaluation and improvement of nuclear safety culture are essential. This study analyzes the current state of nuclear safety culture in Türkiye using the IAEA safety culture framework and proposes leadership actions to strengthen organizational performance.

2. IAEA Safety Culture Framework

The International Atomic Energy Agency defines safety culture as the characteristics and attitudes within organizations and individuals that establish safety as an overriding priority.

The IAEA framework identifies several key attributes of a strong safety culture:

- Leadership commitment to safety;
- Questioning attitude;
- Continuous learning and improvement;
- Open communication;
- Reporting culture;
- Conservative decision-making.

Leadership commitment is considered particularly important because management behavior directly influences employee attitudes and organizational values. Similarly, a strong reporting culture encourages personnel to report concerns, mistakes, and near misses without fear of punishment. Continuous learning enables organizations to incorporate lessons learned from operating experience and international best practices into daily operations.

These principles provide a suitable framework for evaluating the current safety culture of Türkiye's emerging nuclear program.

3. Assessment of Nuclear Safety Culture in Türkiye

Türkiye has achieved significant progress in establishing the foundations of a safe nuclear energy program. The Akkuyu NPP project, the creation of NDK, and cooperation with international organizations have strengthened the country's nuclear infrastructure.

One major strength is the strong governmental commitment to nuclear safety. The establishment of NDK as an independent regulatory authority demonstrates the importance assigned to regulatory oversight and compliance. Furthermore, extensive workforce training programs and international educational opportunities have improved technical competence within the nuclear sector.

Another important strength is the adoption of international standards and best practices. Cooperation with the IAEA and experienced nuclear organizations has supported the development of safety awareness and professional competence.

The Akkuyu project is also unique because it is implemented using the Build-Own-Operate (BOO) model. This model provides access to international expertise and operational knowledge; however, it also introduces challenges associated with managing a multinational workforce. Differences in language, communication styles, and management approaches may present challenges for effective safety-related communication and information sharing if not properly managed.

Although the overall foundation is strong, several challenges remain. The most significant limitation is the lack of domestic operational experience. In addition, reporting culture and questioning attitudes are still developing within the emerging nuclear sector.

The assessment levels presented in Table 1 were determined through qualitative comparison with IAEA safety culture attributes and publicly available evidence from the Turkish nuclear sector.

Table 1: Assessment of Nuclear Safety Culture in Türkiye

IAEA Safety Culture Attribute	Assessment
Leadership Commitment	Strong
Regulatory Oversight	Strong
Technical Competence	Strong
Learning Culture	Moderate
Open Communication	Moderate
Reporting Culture	Moderate to Weak
Questioning Attitude	Moderate to Weak
Conservative Decision-Making	Moderate

The assessment suggests that Türkiye possesses a strong institutional and regulatory foundation but requires continued improvement in organizational learning, reporting behaviors, and questioning attitudes.

4. Organizational Factors Influencing Safety Culture

Several organizational factors explain the identified weaknesses.

The first factor is limited operational experience. Since Akkuyu NPP has not yet accumulated decades of domestic operating history, many current practices rely heavily on international experience rather than locally generated lessons learned.

The second factor is organizational maturity. Safety culture develops gradually through leadership behavior, workforce engagement, and operational experience. Therefore, some cultural attributes are still evolving.

A third factor relates to cultural influences. Such environments may discourage employees from challenging authority or openly reporting concerns unless leadership actively promotes psychological safety.

Finally, the multinational nature of the Akkuyu project creates additional communication challenges. Differences in language, culture, and management practices may affect decision-making processes and information sharing if not properly managed.

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5. Leadership Strategy for Safety Culture Improvement

From the perspective of a Vice President responsible for organizational safety performance, several initiatives are recommended to strengthen safety culture.

The first initiative is establishing a clear safety vision throughout the organization:

"No production, schedule, or financial objective is more important than nuclear safety."

This principle should guide all management decisions and organizational activities.

The second initiative is strengthening reporting culture. Employees should be encouraged to report concerns, mistakes, and near misses without fear of blame. Confidential reporting mechanisms and a learning-oriented response system should be implemented.

The third initiative is increasing leadership engagement. Regular management walkdowns, workplace observations, and direct communication with frontline personnel can strengthen trust and demonstrate visible commitment to safety.

Another important initiative is creating a learning organization. International operating experience, IAEA recommendations, and industry best practices should be systematically reviewed and incorporated into training programs and operational procedures.

Table 2: Proposed Safety Culture Improvement Plan

Objective	KPI	Target
Reporting Culture	Near-miss reports	+50%
Learning Culture	Training completion rate	100%
Employee Engagement	Survey participation	95%
Leadership Presence	Field observations	Weekly
Corrective Actions	Closure rate	>95%

These initiatives can progressively improve reporting behavior, employee engagement, and organizational learning, ultimately supporting a mature and resilient safety culture.

6. Conclusions

This study evaluated the current state of nuclear safety culture in Türkiye using the IAEA safety culture framework. The analysis indicates that Türkiye has established a strong foundation for nuclear safety through regulatory development, workforce training, and international cooperation. The establishment of the Nuclear Regulatory Authority (NDK) and the ongoing development of the Akkuyu Nuclear Power Plant have provided important institutional and technical support for the country's emerging nuclear energy program.

Despite these achievements, several challenges remain. Limited domestic operating experience, developing reporting culture, questioning attitudes, and communication within a multinational workforce

environment continue to represent areas requiring further attention. These challenges are not unique to Türkiye and are commonly observed in emerging nuclear programs during their early stages of development.

To address these issues, this study proposed a leadership strategy focused on visible management commitment, conservative decision-making, open communication, organizational learning, and employee engagement. Strengthening these elements can support the development of a more resilient and sustainable safety culture.

The experience of Türkiye demonstrates that safety culture development must progress in parallel with technological advancement and regulatory maturity. For emerging nuclear nations, long-term success depends not only on the implementation of advanced technologies and effective regulations but also on the continuous cultivation of leadership, learning, and organizational values that prioritize safety above all other objectives.

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