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Safety and Security Concept of Similar ASEAN Working Culture in Experimental Facility of Nuclear Research Reactors

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Abstracts According to previous Thailand's case study on the cultural impact of operators and users in the same working environment of a Nuclear Research Reactor (NRR), the working culture of operators (insiders) was recognized to influence users (outsiders) who work in an NRR experimental facility. Considering user thought thus becomes a significant approach for minimizing human error in working. In 2017, ASEAN Large Nuclear and Synchrotron Facilities Network (ASEAN LNSN) was organized to share large nuclear and synchrotron facilities among ASEAN countries including NRR experimental facilities. Due to human factor impact, it is important to understand whether or not the NRR facility sharing influenced various working cultures on safety and security issues. Thus, this study intends to show how to apply the homogenous working culture concept as evidence to compromise unnecessary concerns and minimize stress among ASEAN users in terms of safety and security in facility sharing through Hofstede's cultural indices: (1) power distance index (PDI), (2) individualism index (IDV), (3) masculinity index (MAS), (4) uncertainty avoidance index (UAI), and (5) long-term orientation index (LTO). A homogenous working culture survey is expected to help provide a foundation for improving safety standards and operational performance across ASEAN's NRR experimental facilities, facilitating cross-border knowledge sharing and collaborative safety and security practices.

Keywords: Hofstede's model, Cultural study, Human factor, Research reactor, ASEAN LNSN

1. Introduction

Organizational culture, encompassing a system of shared values, beliefs, and practices, exerts a profound influence across diverse industries, notably within the high-stakes domain of nuclear science and engineering. This influence is particularly salient in high-risk environments such as those associated with nuclear power plants (NPPs), where safety and security are of paramount importance (Kolaczowski A. et al 2004). A nuanced understanding of the dynamics inherent in organizational culture within NPPs facilities is, therefore, crucial for optimizing operational safety and

minimizing the potential for human error. To effectively mitigate such risks, the rigorous application of Human Reliability Analysis (HRA) is essential.

HRA serves as a fundamental analytical tool for enhancing safety protocols, systematically identifying potential sources of human error, informing robust decision-making processes, and ultimately, contributing to the prevention of accidents. The significance of HRA extends well beyond the scope of Nuclear Research Reactors (NRRs) (Vechgama W. et al. 2024) it plays a demonstrably critical role in ensuring the accuracy and reliability of safety analyses within NPPs (Park J. et al. 2015). Moreover, the versatile HRA framework has

proven valuable in investigations exploring the multifaceted impact of cultural factors on risk management practices among contractors engaged in complex construction (Liu J. et al 2015).

The Thai Research Reactor (TRR-1/M1), the only nuclear research reactor in Thailand operated by the Thailand Institute of Nuclear Technology (TINT), not only supports various nuclear applications but also reflects distinct cultural profiles among its operators and users. The facility's organizational structure creates a clear distinction between operators and users. The Research Reactor Center is responsible for reactor operation, maintenance, instrumentation and control (I&C), as well as planning and technical support, while the users come from various divisions, including research and development (R&D), nuclear technology service, and external collaborations. This separation of roles potentially influences working culture, communication patterns, and decision-making processes within the facility. Our previous study revealed some relational parameters between these groups, such as the moderate correlation in power distance (PDI), indicating a shared acceptance of hierarchical structures, and a negative correlation in long-term orientation (LTO), suggesting differing strategic priorities. These insights emphasize the importance of understanding cultural dynamics to enhance collaboration within nuclear facilities. To extend this research, the current study includes cultural profile comparisons across nuclear facilities in ASEAN countries. A particular focus is placed on the ASEAN Large Nuclear and Synchrotron Facilities Network (LNSN), which facilitates collaboration among research reactors and synchrotron facilities in the region. By analyzing these cultural dimensions, we aim to uncover shared challenges and opportunities for regional cooperation, contributing to the advancement of nuclear science and technology across ASEAN.

2. Background

2.1. Hofstede's model, theoretical framework for Cross-Cultural Analysis

This study adopts Hofstede's renowned cultural dimensions model as a comprehensive theoretical framework (Wu M. et al. 2006) to analyze the interplay of cultural values within the context of NRR operations. Hofstede's model, widely recognized for its applicability (Żemojtel-Piotrowska M. et al. 2023) in cross-cultural organizational research, encompasses the following key dimensions:

- **Power Distance Index (PDI):** This dimension reflects the extent to which less powerful members of an organization or society accept and anticipate an unequal distribution of power. A high PDI score suggests a hierarchical structure with clear lines of authority, while a low PDI score indicates a preference for flatter organizational structures and a greater emphasis on egalitarianism.
- **Individualism vs. Collectivism (IDV):** This dimension measures the relative emphasis placed on individual goals versus collective goals. Cultures with a high IDV score prioritize individual achievement and autonomy, whereas cultures with a low IDV score prioritize group harmony, loyalty, and collective well-being.
- **Masculinity vs. Femininity (MAS):** This dimension assesses the degree to which a culture values assertiveness, competitiveness, and material success (masculine traits) as opposed to cooperation, nurturing, and quality of life (feminine traits).
- **Uncertainty Avoidance Index (UAI):** This dimension captures the level of comfort or discomfort individuals within a culture experience when confronted with uncertainty and ambiguity. High UAI scores reflect a preference for well-defined rules, structures, and procedures, while low UAI scores indicate greater tolerance for ambiguity and risk-taking.
- **Long-Term vs. Short-Term Orientation (LTO):** This dimension distinguishes between cultures that prioritize long-term planning and future rewards (long-term orientation) and cultures that focus on immediate results and fulfilling present obligations (short-term orientation).

By applying this robust framework, the study aims to uncover actionable insights into the cultural similarities and differences that exist between NRR operators and users within the ASEAN region. A nuanced understanding of these cultural dynamics can inform the development and refinement of safety and security protocols, fostering a work environment characterized by effective communication, mutual understanding, and shared commitment to safety.

2.2. Similarity of Working Culture: Operators and Users (Thailand Case Study)

The findings derived from the Thai case study (Weerawat P. et al. 2024) conducted at the TRR-1/M1 research reactor facility revealed intriguing correlations in the cultural indices of operators and users. These patterns were identified through the application of Hofstede's renowned cultural dimensions framework. Positive correlations indicate that both groups share similar tendencies within the respective cultural dimension, reflecting aligned perspectives and behaviors. Conversely, negative correlations highlight divergent tendencies, suggesting that the two groups prioritize different values or exhibit contrasting behaviors in certain aspects of the working culture.

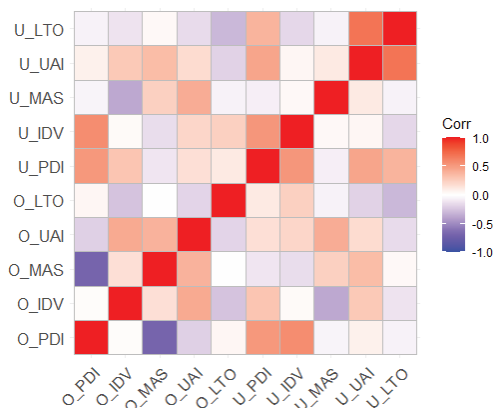


Fig. 1. Pearson Correlation Heatmap of User and Operator Cultural Dimensions from Thailand.

Figure 1 presents the Pearson correlation heatmap between the five cultural dimensions of Hofstede's model, comparing the perspectives of Operators (O) and Users (U) in the Thai Research Reactor. The color gradient indicates the strength and direction of the correlation, with red representing positive correlations, blue representing negative correlations, and white indicating no correlation.

- Power Distance Index (PDI): The analysis revealed a moderate positive correlation in PDI scores between operators and users, indicating a shared acceptance of hierarchical structures within the workplace. This suggests a mutual understanding and emphasis on the importance of respecting authority and maintaining clear lines of communication within the organizational hierarchy.
- Individualism Index (IDV): In contrast to PDI, minimal alignment was observed in terms of IDV. This difference suggests a potential divergence in perspectives regarding collectivist versus individualist tendencies, potentially influencing teamwork dynamics and communication styles.
- Masculinity Index (MAS): A weak positive correlation in MAS scores hinted at some commonalities in the perceived importance of competitiveness and achievement within the work environment, as well as in the acceptance of traditional gender roles. However, the weak correlation suggests that further investigation is needed to fully understand the nuances of these shared values.
- Uncertainty Avoidance Index (UAI): A weak correlation in UAI scores highlighted a modest degree of similarity in the preference for structured environments and clearly defined procedures. This finding implies a shared

inclination towards predictability and risk aversion within the operational context of the research reactor facility.

- Long-Term Orientation Index (LTO): Interestingly, the analysis revealed a negative correlation in LTO scores. This finding suggests a divergence in strategic priorities between operators and users. Specifically, operators appear to demonstrate a stronger inclination towards long-term planning and future-oriented goals, while users may prioritize more immediate or short-term objectives.

2.3. ASEAN Research Reactor

Currently, there are seven nuclear research reactor (NRR) facilities operating in ASEAN countries. These reactors play significant roles in scientific research, education, and peaceful nuclear applications. The facilities are located in five countries as follows:

- Thailand: TRR-1/M1 (1 MW, operational)
- Malaysia: PUSPATI TRIGA Reactor (RTP) (1 MW, operational)
- Indonesia: G.A. Siwabessy Multipurpose Reactor (RSG-GAS) (30 MW, operational), Kartini Reactor (100 kW, operational), and TRIGA Bandung Reactor (TRIGA 2000) (2 MW, operational)
- Philippines: Philippine Research Reactor-1 Subcritical Assembly for Training, Education, and Research (PRR-1-SATER) (subcritical, operational)
- Vietnam: Dalat Nuclear Research Reactor (DNRR) (500 kW, operational)

The study involves an in-depth discussion of cultural profiles and safety culture between operators and users in these ASEAN NRR facilities. The data collection process will cover seven research reactors across the region. Collaboration will be carried out through personal interviews, questionnaires,

and data sharing agreements with key representatives from each facility. In-depth discussions will be conducted with operators and users at each facility. The same Hofstede model applied in the Thai Research Reactor study will be utilized to ensure consistency in cultural dimension analysis across all ASEAN NRR facilities. To the best of our knowledge, no similar studies have been conducted across ASEAN NRR facilities, making this research the first regional effort to investigate cultural profiles and safety culture in the context of nuclear research reactors.

3. Scope of Homogeneous Working Culture in ASEAN NRRs

Within the organizational structure of TINT, the Research Reactor Center assumes primary responsibility for the operation, support, and planning of the TRR-1/M1 reactor. All of operators were involved in that study. As for users, the researchers conducting the research at neutron experimental facilities in the TRR-1/M1 building, including all of neutron application.

This methodology was further extended to ASEAN nuclear research facilities through the ASEAN Large Nuclear and Synchrotron Facilities Network (LNSN). The participant selection encompassed both operators and users from seven nuclear facilities across five ASEAN countries. The cultural profiles of operators and users were collected using Hofstede's model so-called national culture, which can be assessed using 18 questions representing five distinctive dimensions. The survey form consists of three main parts: Part 1 is the Demographic Information Survey, Part 2 is the Nuclear Research Reactor Experience Survey, and Part 3 comprises the 18 questions for the Cultural Characteristics Survey (Park J. et al. 2015). A common statistic used to assess agreement is Intra-class Correlation Coefficient (ICC) and Pearson correlation (r) were employed in this study to analyze the relationships between operators' and users' culture profiles and to

assess the strength and direction of these relationships.

User feedback emerged as a valuable source of insight into the perceived strengths and weaknesses of safety and security protocols within the TRR-1/M1 experimental facility. Users consistently articulated concerns regarding specific aspects of the existing safety measures, prompting the reactor operators to proactively implement procedural improvements. These adjustments, informed by direct user input, contributed to a demonstrable enhancement in operational reliability. This finding aligns with discussions and recommendations put forth at the 2024 ASEAN Nuclear Power and Safety Research (NPSR) Meeting, which underscored the paramount importance of cultivating and maintaining open channels of communication between facility operators and users as a means of proactively identifying and effectively mitigating potential safety concerns.

3.1.Steps Toward Homogeneous Working Culture

This study employs a structured, multi-phased approach to assess the current cultural landscape within ASEAN's NRR facilities and identify steps toward fostering a more homogeneous working culture:

- This study will undertake a structured and multi-phased approach to assess and ultimately cultivate a more homogenous working culture across the diverse NRR landscape within ASEAN member states. The first phase involves identifying and collaborating with representatives from each of the seven operational NRR facilities within the region. Through in-depth discussions, researchers will gather information regarding existing cultural frameworks, established operational practices, and safety protocols employed at each facility, drawing upon valuable insights and prior research facilitated by both the ASEAN NPSR and the LNSN.
- To bridge the gap between research and practice, the study will facilitate interactive workshops and forums where operators and users from different facilities can connect, share experiences, and engage in collaborative problem-solving. These collaborative sessions will be crucial for translating research insights into the development of unified safety and security strategies that are both culturally sensitive and operationally effective.

Through this multifaceted approach, the study aspires to lay a solid foundation for a more cohesive and safety-conscious working culture within ASEAN's NRR community, ultimately contributing to the advancement of nuclear science and technology throughout the region.

3.2.Expected Outcomes

The strategic implementation of a homogeneous working culture framework within ASEAN's NRR community is anticipated to yield a range of significant benefits, ultimately enhancing both safety and cross-border collaboration. By fostering a shared understanding of values, practices, and expectations, this initiative aims to:

- (i) Enhance Cross-Border Collaboration: Aligning cultural practices across diverse NRR facilities will minimize potential misunderstandings and communication barriers that may arise from differing cultural norms. This heightened cultural sensitivity will lay the foundation for stronger, more effective collaboration among regional partners engaged in collaborative research or facility sharing initiatives.
- (ii) Elevate Safety Standards: A unified approach to safety culture will facilitate the establishment and consistent adherence to standardized safety protocols across all ASEAN NRR facilities. This harmonization of safety practices is essential for minimizing risks inherent in facility sharing,

ensuring the well-being of personnel, and upholding the highest standards of nuclear safety and security.

- (iii) **Reduce User Stress and Enhance User Experience:** A consistent and predictable working culture across facilities will alleviate concerns and reduce stress for researchers and visiting users, particularly those unfamiliar with the specific operational environment or cultural norms of a host facility. This will promote a more welcoming and inclusive environment for collaboration and knowledge exchange.
- (iv) **Promote Knowledge Sharing and Continuous Improvement:** Insights gained through comparative cultural analysis and the systematic collection of user feedback will provide invaluable data for ongoing evaluation and improvement of safety and security practices. By fostering open communication and knowledge sharing, ASEAN's NRR community can collectively strive for continuous enhancement of operational efficiency and safety protocols.

By actively promoting cultural alignment within the broader framework of the ASEAN LNSN initiative, this study aspires to not only enhance the operational efficiency and safety of ASEAN's NRR facilities but also unlock their full potential as hubs of scientific collaboration and innovation within the region.

4. Conclusion

This study underscores the critical importance of understanding and addressing the subtle yet powerful influence of cultural dynamics within and across Nuclear Research Reactor (NRR) facilities. Achieving and maintaining the highest standards of operational safety and security requires not only technical expertise but also a nuanced appreciation for the cultural factors that

can shape communication, collaboration, and risk perception within these complex environments.

By harnessing the analytical power of Hofstede's cultural dimensions framework and leveraging the collaborative spirit of the ASEAN Large Nuclear and Synchrotron Facilities Network (LNSN), this study provides a practical roadmap for harmonizing working cultures across ASEAN's diverse NRR landscape. Hofstede's model offers a valuable foundation for understanding cultural tendencies, enhancing cultural insight, and promoting global collaboration by supporting informed management of individuals from diverse cultures, such as by helping managers understand differing communication styles, thereby reducing misunderstandings and optimizing teamwork. However, its application requires careful consideration of certain limitations. The model may not fully capture the complexities of contemporary societies due to its evolving dimensions and the inherent uniqueness of individuals shaped by personal experiences (Helen Wale. 2023). These factors underscore the need to supplement the model with ongoing qualitative research and cultural sensitivity training to provide a more comprehensive and dynamic understanding of cultural dynamics.

This proactive approach to cultural alignment is not merely a matter of promoting interpersonal understanding; it is, rather, an essential investment in enhancing regional safety standards, optimizing operational performance, and fostering a thriving ecosystem of collaborative research and innovation.

The insights generated by this study, coupled with the ongoing commitment to cross-cultural dialogue and knowledge sharing, will empower ASEAN's NRR community to navigate the complexities of a globalized scientific landscape while upholding the paramount importance of safety, security, and collaborative excellence. The study recommends combining quantitative frameworks such as Hofstede's model with qualitative methods like interviews and ethnographic observation, and cultural sensitivity training to achieve a more nuanced understanding of the interplay between culture and safety within ASEAN's NRR facilities.

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