Cultural profiles comparison of operators and users in TRR-1/M1

Weerawat Pornroongruengchok[a], Wasin Vechgama[a, b, c, *]

[a]Thailand Institute of Nuclear Technology (Public Organization)
16 Vibhavadi Rangsit Road, Chatuchak, Bangkok, Thailand

[b]Korea Atomic Energy Research Institute
111, Daedeok-daero 989 beon-gil, Yuseong-gu, Daejeon, Republic of Korea

[c]Nuclear and Radiation Safety Division, Korea National University of Science and Technology
217, Gajeong-ro, Yuseong-gu, Daejeon, Republic of Korea

[*]Corresponding Email: wasin@tint.or.th, wasin@kaeri.re.kr

Abstract: Due to the long-term operation of Thai Research Reactor-1/Modification 1 (TRR-1/M1) that relied on socio-technical systems, human errors were prioritized as crucial safety issues for both operators and users who take advantage of the plants. Human Reliability Analysis (HRA) is an important risk tool in the analysis process for enhancing safety, identifying potential human errors, supporting decision-making, and preventing accidents of TRR-1/M1 containing radioactive material inventory. TRR-1/M1's operators and users have been working in similar environments to support each other for a long time thus the cross-culture characteristics of the two positions become the key point to support the sharing of their experiences to together improve the data supporting the HRA tool, such as performance shape factors (PSFs) and emergency operating procedures (EOPs). This study aims to investigate the cultural profiles and relationships between operators and users working in TRR-1/M1 through five Hofstede indices, including (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). As a result, TRR-1/M1 operators and users consistently showed the PDI positive correlation because of the influence within the organizational structure, while the negative LTO correlation reflected their different working goals.

Keywords: Hofstede's model, Cultural study, Human reliability analysis, TRR-1/M1.

1. INTRODUCTION

The significance of human actions within the operational framework of the Thai Research Reactor-1/Modification 1 (TRR-1/M1) cannot be overstated. Since its establishment in 1962 under the auspices of the Thailand Institute of Nuclear Technology (TINT), TRR-1/M1 stands as Thailand's pioneering nuclear research reactor. Over the extensive operational history, the cooperation between socio-technical systems and human involvement has emphasized the importance of addressing human errors as paramount safety concerns for both operators and users of the facility. TRR-1/M1, like other nuclear work environments worldwide, contains hazardous materials produced from fission reactions. This necessitates the rigorous application of Human Reliability Analysis (HRA) as a fundamental tool for risk mitigation. HRA serves multifaceted roles in enhancing safety protocols, identifying potential human errors, facilitating informed decision-making, and avoiding accidents within the facility. For example, the HRA approach in Nuclear Power Plants (NPPs) is critical for ensuring the accuracy and reliability of safety analyses [1,2]. Not only NPPs, but the HRA framework can also investigate the impact of cultural factors on contractors' risk management in construction projects [3,4]. It explores the interaction between globalization and occupational safety, examining how cultural values, particularly those outlined by Hofstede, intersect with safety climate and risk-taking behavior in multinational engineering organizations [5]. This cultural exchange facilitates the sharing of experiences, thereby enriching the data that underpins HRA methodologies, including performance shape factors (PSFs) and emergency operating procedures (EOPs). Furthermore, the cultural landscape within TRR-1/M1 can be characterized by diverse backgrounds, reflecting the collaborative nature of their nuclear research environment. Operators and users, drawn from varied cultural contexts, navigate shared operational challenges, thereby fostering a rich exchange of knowledge and experiences. This intercultural dynamic underscores the need to examine the cultural dimensions shaping professional interactions and decision-making processes within TRR-1/M1. This study aims to utilize Hofstede's cultural dimensions framework to present the

contrasting cultural profiles and explore the relationships between operators and users within the TRR-1/M1. Hofstede's cultural dimensions constitute a valuable research paradigm within the realms of intercultural communication, cross-cultural psychology, and international management [6], offering insights into how cultural factors influence human performance and decision-making processes across diverse global contexts. Its application facilitates a deeper understanding of how cultural nuances impact organizational working and the effectiveness of risk management strategies. Hofstede specifically suggests the power distance index (PDI), individualism index (IDV), masculinity index (MAS), uncertainty avoidance index (UAI), and long-term orientation index (LTO), to determine prevailing cultural tendencies among operators and users at the TRR-1/M1 nuclear reactor. Moreover, this research contributes to showing the intersection of culture and safety within nuclear research reactor facilities, offering valuable insights into the cultural dimensions that shape operational practices and risk management strategies.

2. METHODOLOGY

2.1 COLLECTION OF CULTURAL PROFILES

Within the organizational structure of TINT, the Research Reactor Center (RRC) assumes primary responsibility for the operation, support, and planning of the TRR-1/M1 reactor. A total of 11 TRR-1/M1 operators, consisting of 9 Licensed Operators and 2 Supervisors, were involved in this study. As for users, there were also 11 internal and external researchers conducting the research at neutron experimental facilities in the TRR-1/M1 building, including neutron imaging, radioisotope production, gem irradiation, and neutron activation analysis. 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. Table 1 summarizes the contents of the 18 questions (Q1 to Q18) and provides a brief explanation of each dimension, respectively. 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. Once respondents have marked all the values for the questions, the index value of each dimension can be calculated using the corresponding formula provided in equation (1)-(5) [7,8].

Table 1. Questionnaires for the national culture – reproduced from [8]

Part 3 suggestion	No.	Questions	Rating scale
Please think of an ideal job, disregarding your present job, and rate how the following below is important for you.	Q1	Have sufficient time for your personal or family life	1 = Utmost importance 2 = Very important 3 = Moderate importance 4 = Little importance 5 = Very little or no importance
	Q2	Have good physical working conditions (good ventilation and lighting, adequate workspace, etc.)	
	Q3	Have a good working relationship with your direct superior	
	Q4	Have the security of employment	
	Q5	Work with people who cooperate well with one another	
	Q6	Be consulted by your direct superior in his/her decisions	
	Q7	Have an opportunity for advancement to higher level jobs	
	Q8	Have an element of variety and adventure in the job	
In your private life, how important is each of the following to you?	Q9	Thrift	1 = Very seldom 2 = Seldom 3 = Sometimes 4 = Frequently 5 = Very frequently
	Q10	Respect for tradition	
Based on your work experience, please answer the following.	Q11	How often do you feel nervous or tense at work?	1 = Never 2 = Seldom 3 = Sometimes 4 = Usually 5 = Always
	Q12	How frequently are subordinates afraid to express disagreement with their superiors?	
In your opinion, to what extent do you agree or disagree with each of the	Q13	Most people can be trusted	1 = Strongly agree 2 = Agree 3 = Undecided 4 = Disagree
	Q14	One can be a good manager without having precise answers to most questions that subordinates may raise about their work	

Part 3 suggestion	No.	Questions	Rating scale
following statements?	Q15	An organization structure in which certain subordinates have two bosses should be avoided at all costs	5 = Strongly disagree
	Q16	Competition between employees usually does more harm than good	
	Q17	A company's or organization's rules should not be broken - not even when the employee thinks it is in the company's best interest	
	Q18	When people have failed in life, it is often their own fault	

Each index can be described and calculated as follows [7]

1. Power Distance Index (PDI): This dimension measures how much a society accepts and expects unequal distribution of power. High power distance cultures accept hierarchical structures, while low power distance cultures prefer more equality in power distribution.

$$PDI\ value = -35 \cdot Q3 + 35 \cdot Q6 + 25 \cdot Q12 - 20 \cdot Q15 - 20 \quad (1)$$

2. Individualism Index (IDV): This dimension reflects the degree to which individuals prioritize their personal interests over the interests of the group (individualism) or vice versa (collectivism). Individualistic cultures emphasize personal freedom and achievement, while collectivistic cultures prioritize harmony and group cohesion.

$$IDV\ value = -50 \cdot Q1 + 30 \cdot Q2 + 20 \cdot Q4 - 25 \cdot Q8 + 130 \quad (2)$$

3. Masculinity Index (MAS): This dimension refers to the distribution of roles and values between genders. Masculine cultures emphasize assertiveness, competition, and material success, while feminine cultures prioritize nurturing, cooperation, and quality of life.

$$MAS\ value = 60 \cdot Q5 - 20 \cdot Q7 + 20 \cdot Q13 - 70 \cdot Q18 + 100 \quad (3)$$

4. Uncertainty Avoidance Index (UAI): This dimension measures the extent to which a society feels uncomfortable with uncertainty and ambiguity. Cultures with high uncertainty avoidance tend to have strict rules, strong beliefs, and a low tolerance for deviant behavior, while cultures with low uncertainty avoidance are more accepting of ambiguity and change.

$$UAI\ value = 25 \cdot Q11 + 20 \cdot Q14 - 50 \cdot Q16 - 15 \cdot Q17 + 120 \quad (4)$$

5. Long-Term Orientation Index (LTO): This dimension reflects the degree to which a society values long-term goals, persistence, and thriftiness versus short-term gratification and tradition. Cultures with a long-term orientation emphasize perseverance, thrift, and respect for tradition, while those with a short-term orientation prioritize immediate results and adaptability.

$$LTO\ value = -20 \cdot Q9 + 20 \cdot Q10 + 40 \quad (5)$$

2.2 STATISTICAL ANALYSIS

A common statistics used to assess agreement is Intra-class Correlation Coefficient (ICC). The ICC is a statistical measure utilized to assess the reliability or consistency of measurements made by different raters or methods on the same subjects or items [9]. The ICC for operators and users, derived from the five indices, were calculated using R software. Additionally, the average values of operators and users, as well as Thailand nuclear staff, will be compared with those of the general occupation in Thailand [10]. The ICC values were interpreted according to the guidelines [11]: less than 0.50 indicates poor reliability, between 0.50 and 0.75 suggests moderate reliability, between 0.75 and 0.90 indicates good reliability, and above 0.90 suggests excellent reliability.

Pearson correlation (r) was also employed in this study to analyze the relationships between operators' and users' culture profiles and to assess the strength and direction of these relationships. The r is a statistical measure that quantifies the degree of linear association between two continuous variables. It assesses how much one variable changes when the other variable changes systematically. [12]. The r ranges from -1 to +1,

where: r=−1 indicates a perfect negative linear relationship, meaning that as one variable increases, the other variable decreases proportionally. r=+1 indicates a perfect positive linear relationship, meaning that as one variable increases, the other variable also increases proportionally. r=0 indicates no linear relationship between the variables.

3. RESULTS AND DISCUSSION

Table 2. Index values of operators and users of TRR-1/M1

ID	PDI	IDV	MAS	UAI	LTO
Operator 1	-10	35	80	95	20
Operator 2	-10	55	40	75	20
Operator 3	-20	35	100	90	40
Operator 4	50	35	60	105	40
Operator 5	50	-20	-100	5	40
Operator 6	15	105	100	105	40
Operator 7	15	55	50	90	40
Operator 8	35	80	-30	180	20
Operator 9	25	60	-100	20	40
Operator 10	45	55	-100	125	40
Operator 11	75	80	-80	30	20
User 1	15	75	20	175	80
User 2	-65	25	10	105	40
User 3	35	55	-60	105	60
User 4	70	80	150	235	60
User 5	-30	80	-60	60	40
User 6	30	80	-170	185	40
User 7	-15	85	30	15	0
User 8	10	80	10	130	40
User 9	5	55	-110	130	60
User 10	70	80	-10	75	40
User 11	95	80	-130	145	60

Table 3. Averaged index values obtained from all participants and ICC coefficients

Index	Thailand operator	Thailand user	Thailand nuclear staff	General occupation in Thailand [gen occu]
PDI	24.54545	20	22.27273	64
IDV	52.27273	70.45455	61.36364	19
MAS	1.818182	-29.0909	-13.6364	34
UAI	83.63636	123.6364	103.6364	64
LTO	32.72727	47.27273	40	67
ICC	0.907		0.3	

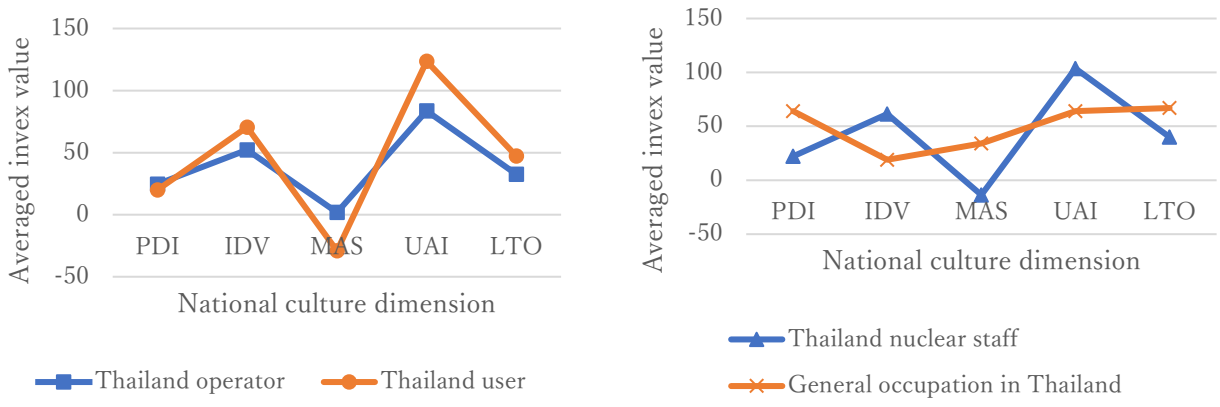

Figure 1. National culture profiles of operators and users of TRR-1/M1 (left) and comparison with general occupation in Thailand (right)

Tables 2. and 3. present the calculated index values for each participant in the study across the five dimensions, as well as the general occupation in Thailand, along with the ICC values. The ICC value for operators and users was 0.907, indicating excellent reliability and suggesting that the cultural profiles within the reactor's environment are consistent. While ICC value when comparing operators and users with the general occupation in Thailand was 0.3, indicating poor reliability and highlighting the unique cultural dynamics of the nuclear field compared to the general workforce. Moreover, Figure 1 dominantly illustrates the variations of the averaged index values for TRR-1/M1 operators, users, and the Thai workforce. It is important to explain their culture differences in each index in the following;

PDI: This measures the acceptance of hierarchical order. Operators had an average PDI value of 24.55, while users had an average of 20.00. Both values are considerably lower than the PDI for the general occupation in Thailand, which is 64.00, indicating a preference for more egalitarian structures among reactor staff compared to the general Thai workforce.

IDV: This dimension reflects the degree to which individuals are integrated into groups. Operators had an average IDV value of 52.27, whereas users had a higher average of 70.45. This suggests that users, many of whom are researchers and lecturers, place a higher value on individual autonomy compared to operators. The general occupation in Thailand scored 19.00, highlighting a more collectivist culture in the broader Thai workforce.

MAS: This dimension looks at the distribution of emotional roles between genders. Operators had a slightly positive MAS value of 1.82, while users had a negative value of -29.09, indicating that users value cooperation and quality of life over competition and achievement. The general occupation in Thailand had a MAS value of 34.00, representing a more competitive environment.

UAI: This measures the tolerance for uncertainty and ambiguity. Operators scored 83.64 and users scored 123.64, both significantly higher than the general occupation in Thailand, which scored 64.00. This indicates that both groups prefer structured environments with clear rules, which is critical in the context of a research reactor.

LTO: This dimension reflects the focus on future rewards versus immediate results. Operators had an average LTO value of 32.73, and users had 47.27. The general occupation in Thailand scored 67.00, indicating a strong long-term orientation in the broader Thai workforce.

Table 4. Pearson correlation between operators (O) and users (U) of TRR-1/M1 for each index

	O_PDI	U_PDI	O_IDV	U_IDV	O_MAS	U_MAS	O_UAI	U_UAI	O_LTO	U_LTO
r	0.523		0.032		0.241		0.183		-0.299	

Table 4 displays the Pearson correlation coefficients between the cultural profiles of operators and users for each dimension. The analysis reveals varying degrees of association between the cultural dimensions of operators and users. Specifically, the moderate positive correlation in PDI suggests that as the power distance within the operators' domain increases, it tends to align with higher power distance perceptions among the users of the TRR-1/M1 reactor. This implies a similarity in the hierarchical structure and authority perceptions between the operators and the reactor users especially from the same organization. On the other hand, the negative correlation in LTO suggests that as the operators prioritize long-term goals and planning within the reactor operations, there is a tendency for the users to exhibit a lower emphasis on long-term orientation. This could indicate a potential mismatch between the operators' focus on strategic planning and the priorities of the users within the reactor context. The IDV dimension showed a very weak correlation, indicating minimal alignment in the emphasis on individual versus collective goals between the two groups. The MAS dimension had a slightly higher correlation, suggesting some commonality in attitudes towards competitiveness and nurturing roles, though it remained relatively weak. Lastly, the UAI dimension exhibited a weak correlation, implying a modest similarity in their preference for structured environments. Both ICC and Pearson correlation can provide a comprehensive understanding of the reliability of measurements and the relationships between cultural profiles among operators and users within the TRR-1/M1 facility.

4. CONCLUSION

In conclusion, this study highlights significant cultural differences between operators and users of the TRR-1/M1 reactor using Hofstede's cultural dimensions. The findings indicate distinct values and preferences in areas such as power distance, individualism, masculinity, and uncertainty avoidance, reflecting the unique demands of their respective roles. These findings carry significant implications for personnel management and training within the TRR-1/M1 reactor. Understanding the cultural profiles can facilitate the tailoring of communication strategies, improvement of teamwork dynamics, and enhancement of overall safety and efficiency. Future research could investigate the impact of cultural training programs on enhancing intercultural competence among reactor staff. Additionally, incorporating the Indulgence vs. Restraint (IVR) dimension may expand on these findings, providing a more comprehensive understanding of the cultural environment. More detailed statistical analyses will also be employed to further examine the nuances of the Masculinity vs. Femininity (MAS), Individualism vs. Collectivism (IDV), and Uncertainty Avoidance Index (UAI) dimensions. The cultural profiles between operators and users well inform targeted interventions aimed at enhancing operational safety and fostering cross-cultural collaboration within TRR-1/M1. Additionally, it provides a basis for future research endeavors aimed at exploring the cultural implications of human performance within nuclear research environments and other multinational research reactor facilities.

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