Role of Domestic Research Reactor to Introduce Nuclear Power in Cambodia: Assessment of Government Official's Perception

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1. Introduction

Research Reactors (RRs) have become very important to countries interested in Nuclear Power (NP) development. RR offers straightforward support as an ancillary component to develop and implement NP program. An action plan of an RR is very much analogous to a Nuclear Power Plant (NPP), which consists of infrastructure, regulatory body, commissioning, construction, operation, maintenance, radioactive waste management and decommissioning. RRs and Power Reactors (PRs) are both nuclear reactors, which operated using fission chain reaction, but they are different in scale and utilization [1].

Cambodia is a developing country interested in NP development. Due to the extremely high demand for electricity, the government has strongly considered developing NP program to cope with the demand. In order to introduce a new NPP to satisfy the safety requirements, standards, security, safeguards and the economic sector, the government is considering either to start with an RR or directly to the NPP without domestic RR [2].

The objective of this paper is to explore the importance and roles of a domestic RR in introducing a new NPP to Cambodia. This data was collected by conducting the survey questionnaires. These questionnaires were distributed among Cambodian government officials in the Ministry of Mines and Energy (MME), especially in the Department of Energy Technique and Nuclear Science (DETNS). It was also given to the government officials from other countries who handle the Master's program of Nuclear and Radiation Safety in the Korea Institute of Nuclear Safety (KINS). This survey aims to pave the way to the utilization of a domestic RR to introduce effective NP program and make recommendations to the Cambodian government with that goal in mind.

2. Literature Survey

The International Atomic Energy Agency has published the milestone approach in which they differentiated 19 national infrastructure issues to be addressed by countries considering introduction of a NP program [3]. Having an RR or other facilities that involve nuclear material, means that country has already become familiar with these issues, for example, nuclear security, safeguards accountability, and regulatory oversight. RR programs are one of the nuclear safety cultures that can be applied to more advanced NP program [4].

The ways in which RRs significantly support and improve NP programs is the concern of this study. The main uses of RRs are for research, training, and development in nuclear and radiation science applications. In contrast, PRs have a single function, which is to generate electricity, and are much larger than RRs. The countries looking forward to launching NPPs, first start with a foundation RR. In the case of Vietnam, this country has successfully developed human resources and strategies, and announces a NP program which will be constructed in 2020 alongside their two existing RRs [5]. However, construction of 4 United Arab Emirates NPPs started in 2012 without that country operating their own RR. [6].

3. Methods and Results

3.1 Development of Questionnaire

The understanding and awareness of the role of domestic RRs in preparing for NP program from the major people as government officials are very important for decision-maker to make the right decision whether to start with a domestic RR or begin directly with a NP program. This research observed positive and negative perceptions from the Cambodian and foreign government officials using developed close-questionnaires (multiple choices) as specific tools for assessment. The questions were designed to eliminate overlapping questions and complexity, in order to be easily understood and give the accurate answer. The main concepts of the questionnaire are listed in Table I.

Table I: Questionnaire

A. Cambodia's NP vision
i. NP development in Cambodia
ii. Necessity of NP for Cambodia
iii. Priority of RR to precede a NP
iv. Advantages of domestic RR to Cambodia
v. Challenges of introducing NP without RR
vi. Benefit of RRs to NPPs
vii. Public acceptance of RR programs

B. Role of RR for development in Cambodia

viii. Contribution of RR to development in Cambodia
ix. Utilization of a domestic RR
x. Multi-purpose of RR utilization for public services
xi. RR essential role in education, medical, agriculture and industrial sectors

C. Nuclear Safety improvement

xii. RRs improve safety system of NP
xiii. RRs and nuclear safety culture
xiv. RRs improve security and safeguard in NP
xv. Risks of direct introduction NP without RRs
xvi. TRIGA Mark II is a suitable RR technology for Cambodia

D. Management of Human Resource

xvii. Role of RRs in developing human resources
xviii. Necessity of RRs as laboratory for domestic and international scientists and researchers
xix. Work in RRs provides training to NPP staff
xx. A domestic RR can build up staff competency suitable for working in NPP

E. National Infrastructure

xxi. RRs have improved governmental and regulatory infrastructure for NPP
xxii. Nuclear proliferation resistance program of RR in Cambodia
xxiii. Cambodia can meet the requirement to construct RR on aspects of safety requirements, regulatory controls, management of safety, site evaluation, commissioning, operation, waste management and decommissioning
xxiv. Significant role of domestic RR to improve safety requirements, technical and administrative requirement to construct a new NPP
xxv. Suggestion to countries which consider developing NPP should begin with domestic RR

3.2 Results

The target group to distribute the questionnaires were 70 individuals at all levels included supporting and administrative staff were taken into account with Positions, age, and gender. A suitable number of 50 responders were replied to 25 questionnaires, thus, entire responses were 1250. Each questionnaire gave the multiple answers ranged from 1 to 5, that 1 represents the strongly agree, 3 for neutral, and 5 for strongly disagree. This survey provided as hard and soft copies with an introduction about NP development in Cambodia. Responder's recorded are shown in Table II.

Table II: Responder's recorded

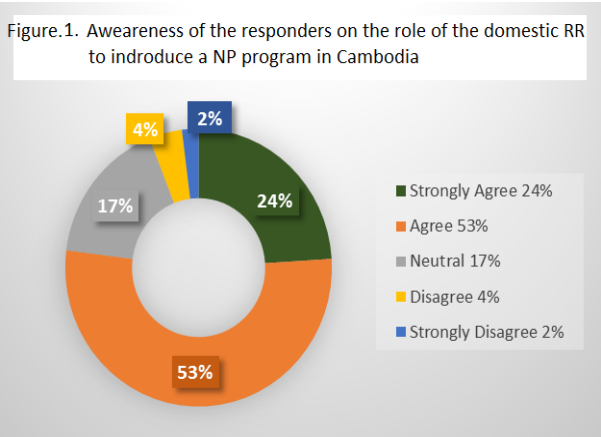
Group No	Responder's Position and Gender	No. of Responders
1	Director General (Male)	2
2	Deputy Director General (Male)	3
3	Senior Scientific Officers (Male)	17
4	Senior Scientific Officers (Female)	5
5	Scientific Officers (Male)	13
6	Scientific Officers (Female)	3
7	Supporting Staff (Male)	5
8	Administrative Staff (Male)	2
Total Number of Responders		**50**

Responders were not forced to provide the answers and kept anonymous to get more transparent and actual responses. Each responder was allowed only one time to take this questionnaire in a limited time. The number of responses calculated as the percentage. The result of the present study indicated that the majority of the responders have a good perception of the fundamental role of the domestic RR to introduce NP program. The number of responses and results of these calculations are illustrated in Table III and Figure I.

Table III: Number of responses to different ranges

Response Range	Numbers of Responses
Strongly Agree	307
Agree	663
Neutral	212
Disagree	54
Strongly Disagree	14
Total	1250

Figure.1. Awareness of the responders on the role of the domestic RR to indroduce a NP program in Cambodia



The data was analyzed and demonstrated that 24% of the responders were strongly agree and 53% agree. These numbers proved that most of the responders realize the importance of RRs for NPP development. In another 17% of the responders were neutral, they were unclear whether domestic RR has a significant impact to Cambodia for developing NP or not. The rest 6%, they

considered the role of the RR is not necessary for Cambodia to develop NP program.

3.3 Internal Consistency Check of Questionnaire

Internal consistency is an essential element to investigate questionnaire's authenticity and reliability; generally, it measures the Cronbach's alpha in a computer code. The questionnaire has been analyzed for the reliability by using computer code IBM SPPS Statistics (version 22.0). This computer code is a very effective and flexible tool to find out the reliability of language test results. Cronbach's alpha is used to estimate the proportion of variance that is standardized or consistent with a set of test scores. It ranged from 0.00 (if no variance is reliable and consistent) to 1.00 (if all variance is reliable and consistent) [7]. The Cronbach's Alpha value of this questionnaire remains 0.82 nicely above the acceptable value 0.7, it's indicated that the questionnaire is reliable and consistent. The statistically analyzed internal consistency of questionnaire is shown in Table IV.

Table IV: Reliability statistic of questionnaire

Mean	Variance	Std. Deviation	Cronbach's Alpha
51.1	67.561	8.21956	**0.82**

4. Discussion

As early stage to introduction a NP program, Cambodian government has been paying much attention to decision making on whether to prioritize with a domestic RR or begin with NPP directly to achieve and ensure the goal of safety, security, safeguard, and efficiency of the plant. According to the situation above, this study was conducted to support decision makers of Cambodia to maintain and enhance the goal.

In this research, most of the responders are Cambodian government officials from MME, DETNS, and the other responders are foreign government officials. They are working as the regulatory body in their countries. These people are the good participants because they have the broad aspect and experience relate to this study. The responses show that there is not much variance in understanding and give the actual answer.

It has been observed that most of the responders acknowledge the role of RR to introduce NP program in Cambodia. In area of Cambodia's nuclear vision and role of RR for development, most of the responders are well support that Cambodia really needs to develop NP program with a domestic RR and the benefit of RR utilization to public services. They fully understood the advantages of a domestic RR and the challenges of introducing NP program without a domestic RR.

Some responses are "neutral" in an area of questionnaire related to nuclear safety improvement; it indicated that Cambodia nuclear safety system is not well developing yet. Any ways the majority of the responders agreed that a domestic RR program would improve the nuclear safety, security and safeguard.

The result from the response in the area of questionnaire that mentioned about management of human resource, and national infrastructure shown that Cambodia has very limited human resource to start NP program; the governmental and regulatory infrastructure are still lack. Nearly all of the responders agreed that a domestic RR plays as very important sector to develop this area effectively.

However, the general overview of responders indicated that they have the good perception about the role of domestic RR, and strongly recommended and suggested below:

- ⊙ Cambodian government should begin with a domestic RR as priority step to developing NP program
- ⊙ Cambodia need to pay much attention on development of human resource as the back bone to sustain the NP program, a domestic RR is a special tool to build up staff competency
- ⊙ Strengthen the national nuclear infrastructure, legal framework, and nuclear law with a domestic RR
- ⊙ The government should be concerned about the public acceptance by spreading the information to public in any ways such social medias, and make sure the public become aware of the NP program
- ⊙ Improve the nuclear non-proliferation system as the main concern of the world
- ⊙ Extend the cooperation and collaboration with other major nuclear countries to share the experience and knowledge

5. Conclusions

As discussed earlier, this study was conducted in a good environment with all levels of government officials involving NP program that produced the responses with more authenticity and reliability. The result show that the responders have very well understanding about the role of domestic RR to pave the way to introduce a new NP program, and strongly recommended Cambodian government should look forward to first starting with a domestic RR to achieve NP program efficiently. In-company with multipurpose utilization of RR for education and training, scientific research, technology development, radioisotope and nuclear medicine productions, materials analysis technology, neutron beam science, and applications; Cambodia will receive the great benefit to develop economic, education sector, and social life.

Furthermore, to ensure the sustain NP program, Cambodia need to focuses on the issues of human resource development; strengthen the national infrastructure, legal framework, nuclear law, nuclear

safety, public concern, and nuclear non-proliferation program. As the results extracted from this study a domestic RR plays as very effective role to cope with the issues above.

This research can be used as a reference for countries considering introducing first NPP or operating the NPP. This survey has brought the important concepts and experience of using domestic RR to improve NP program. However, significantly related studies are needed to follow after this research such as a suitable type of RR, management of RR, public concern on RR program, and the efficiency of RR utilization.

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