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Nuclear Education in Cambodia and the Challenge of Bridging the Knowledge Gap

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Abstract: Nuclear technology offers significant potential for addressing Cambodia's growing energy demands, healthcare advancements, and agricultural improvements. However, a substantial knowledge gap and limited educational infrastructure hinder Cambodia's adoption and effective utilization of nuclear technology. This paper explores the current state of nuclear education in Cambodia, identifying key challenges such as inadequate programs of study, a scarcity of trained educators, limited access to research facilities, and a lack of public awareness about nuclear science's benefits and risks. This study highlights the critical need for enhanced investment in nuclear education and training through a comprehensive analysis of existing educational programs, policy frameworks, and stakeholder perspectives. Moreover, strengthening education and fostering international partnerships are essential to bridge the knowledge gap. Enhanced curricula and public awareness initiatives can help Cambodia safely and effectively adopt nuclear technology, supporting sustainable development and energy security.

Keywords: nuclear radiation, nuclear education, radiation challenge, nuclear radiation knowledge.

I. Introduction

In 1958 [1], Cambodia first joined the International Atomic Energy Agency (IAEA), which is an international organization that promotes the peaceful use of nuclear energy and works to prevent its use for military purposes, including nuclear weapons. For some reason, Cambodia withdrew in 2003 and rejoined in 2009 [2]. Cambodia established the Office of Atomic Energy Technology (OAET) in 2005, which has since been elevated to the Department of Nuclear Science and Technology (DONST) within the General Department for Energy of the Ministry of Mines and Energy (MME) [3]. Cambodia is promoting the peaceful and knowledgeable use of nuclear energy as part of its strategy for sustainable social and economic development, with a strong focus on safety and international cooperation. Through the Department of Science and Technology (DST), the country has established key partnerships with the Russian Federation and China. With Russia, several agreements have been signed since 2015, including the creation of a joint working group, a nuclear information center, and a comprehensive cooperation agreement to support nuclear infrastructure, education, and technology development. Similarly, Cambodia's 2017 MoU with China's National Nuclear Corporation focuses on human resource development, public awareness, and assessing the country's readiness for future nuclear energy projects [4]. Over the past two decades, Cambodia has undertaken various initiatives to develop its nuclear sector, particularly in the areas of policy formulation, international cooperation, and capacity building. These efforts have included the establishment of institutional frameworks, such as the Department of Nuclear Science and Technology (DONST), as well as the signing of multiple Memoranda of Understanding (MoUs) with international partners to promote the peaceful use of nuclear energy. Despite these positive steps, the general public in Cambodia continues to have limited knowledge and understanding of the benefits, applications, and safety aspects of nuclear technology. Public perception is often shaped by misconceptions or a lack of accessible information, which poses a significant barrier to broader acceptance and support for nuclear-related initiatives. Moreover, Cambodia's nuclear infrastructure remains at a very early stage of development. The country currently lacks key facilities such as nuclear power plants, research reactors, and nuclear fuel cycle installations, all of which are essential for advancing nuclear science, conducting research, and supporting energy diversification. At present, the use of radioactive sources in Cambodia is confined to peaceful applications in a few sectors: medical treatments (particularly in oncology), industrial

processes (such as radiation gauges for quality control), and agricultural practices (like food irradiation and pest control). The absence of advanced infrastructure and limited educational exposure further underscores the urgent need for investment in nuclear education and training programs to build national capacity and bridge the existing knowledge gap within the Cambodian population.

Cambodia faces several interconnected challenges in developing nuclear knowledge, primarily due to a shortage of qualified human resources and limited educational opportunities in nuclear science. In contrast, neighboring countries like Vietnam and Thailand have operated research reactors for decades, structured academic and training programs, and substantial output of scientific publications in nuclear technology.

II. Human Resource Challenge

Due to a limited foundation in nuclear science and technology, Cambodia only initiated the development of human resources in this field in 2019. In contrast, neighboring countries have made significantly earlier progress. Thailand established its research reactor (TRR-1/M1) in 1977 [5] and has since built a strong nuclear education and research infrastructure. Similarly, Vietnam has operated the Dalat Nuclear Research Reactor since 1984 [6], supporting academic programs and producing a substantial volume of nuclearrelated research. These regional differences highlight Cambodia's delayed entry into the nuclear field and underscore the urgent need for investment in nuclear education, training, and international collaboration to bridge the knowledge and capacity gap.

The data presented in Figure 1, that is provided by the CAM-ATOM [7], clearly indicates that Cambodia still has a limited human resource in the field of nuclear science. With only 14 students pursuing nuclearrelated degrees in Russia as of 2025—and the majority still in the process of completing their studies—it is evident that the country is in the very early stages of building its technical and academic capacity. The absence of any PhD graduates and the small number of completed degrees overall further highlight the gap in advanced expertise. This limited human capital underscores the urgent need for Cambodia to invest in long-term strategies for nuclear education, research collaboration, and local capacity-building if it aims to responsibly adopt and manage nuclear technologies in the future.

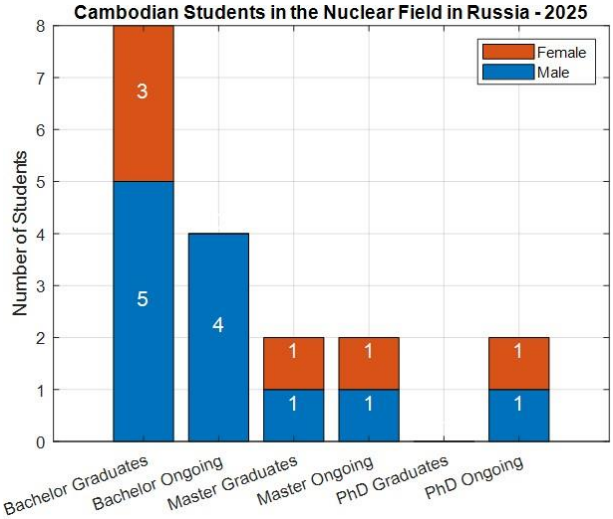

Figure 1 The Cambodian students who are studying nuclear major in Russia in 2025

Compared to neighboring countries' human resources, Vietnam produces over 200 nuclear graduates annually through its domestic VinAtom University [8], while had 62 nuclear medicine physicians and 130 non-medical personnel, including medical physicists, nuclear medicine technologists, radiopharmacists, radiochemists, and nuclear medicine nurses in 2016 [9]. Even Laos, with fewer resources, has established nuclear medicine programs with foreign partners. However, Cambodia currently lacks a dedicated nuclear science or engineering program at the university level, as detailed in the section below. Due to the shortage of qualified human resources and nuclear experts in Cambodia, education programs—from high school to university level—remain

underdeveloped, while research publications and job opportunities in the nuclear field are also highly limited.

III. Education Program Challenge

One of the fundamental obstacles to developing nuclear science expertise in Cambodia originates at the high school level, where a growing majority of students are choosing the Social Science track over the Science (Real Science) track. This educational divergence has long-term implications for the country's ability to build a competent workforce in science and technology sectors, including nuclear energy, medicine, and engineering. In recent years, the proportion of students opting for the Science track has dropped dramatically—from over 90% in 2013 to just 28.7% in 2024, as detailed in Figure 2, according to the Ministry of Education's national exam statistics. This trend reflects a systemic issue: students often perceive science subjects as more challenging, with higher risks of academic failure and fewer immediate job opportunities. As a result, fewer students develop foundational skills in physics, chemistry, and mathematics—core disciplines essential for pursuing nuclear science at the university level. This lack of early engagement with scientific education severely restricts the pool of candidates who are academically prepared and motivated to enter nuclear-related fields in higher education. Consequently, Cambodia faces not only a knowledge gap, but also a capacity gap in training the scientists, engineers, and regulatory experts needed to safely and effectively explore nuclear applications for energy, health care, and agriculture.

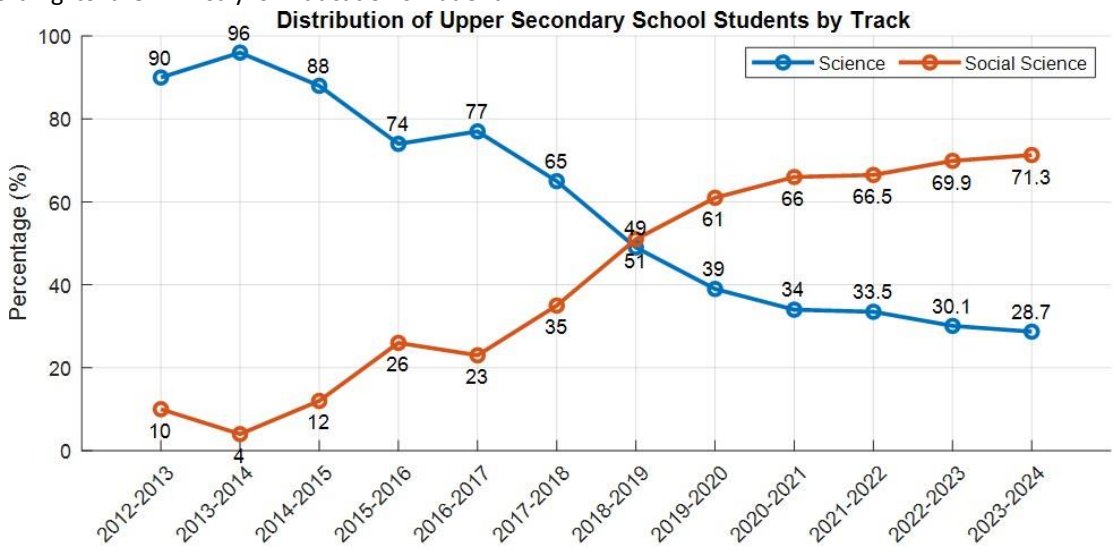

Figure 2 Distribution (percent) of upper secondary school students by science and social science tracks [10]

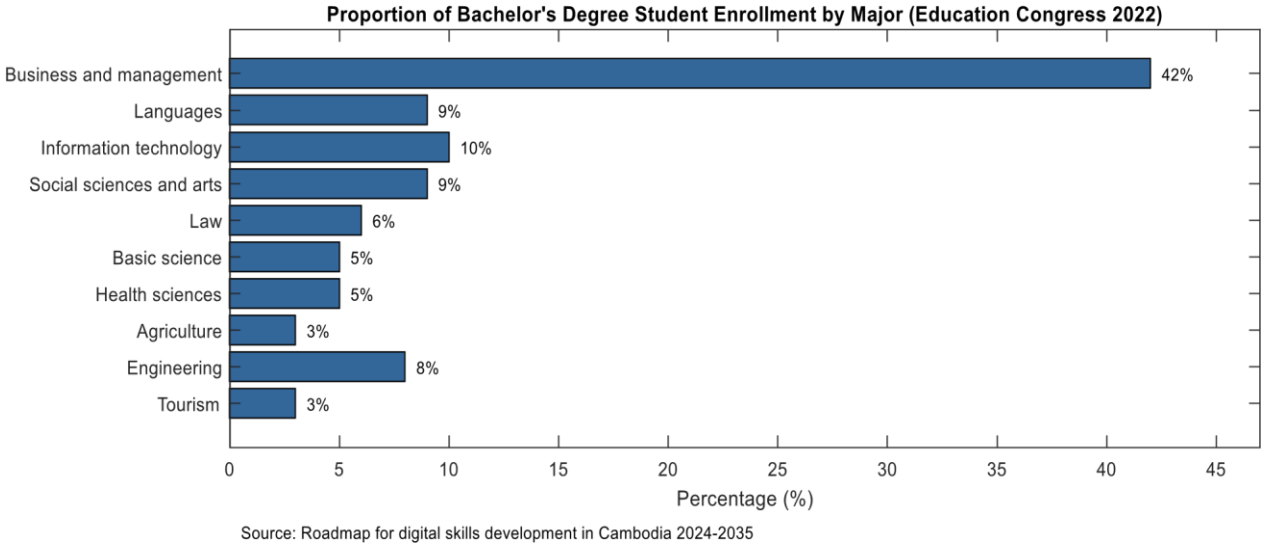

Figure 3 Student Enrollment by Academic Major in Cambodian Higher Education (University Level) [11]

As shown in Figure 3, student enrollment in STEM-related fields at the university level remains remarkably low in Cambodia, highlighting a significant barrier to advancing scientific and technological capacity, including nuclear science. Specifically, only 8% of students are enrolled in engineering, 5% in health sciences, 5% in basic sciences, and just 3% in agriculture. These numbers are disproportionately low when compared to the 42% of students enrolled in business and management, signaling a trend where students overwhelmingly favor fields perceived as offering quicker or more stable career pathways. This imbalance is particularly concerning for the development of nuclear-related human resources, as disciplines such as engineering, physics, and health sciences are essential foundations for building capacity in nuclear energy, nuclear medicine, and radiation safety.

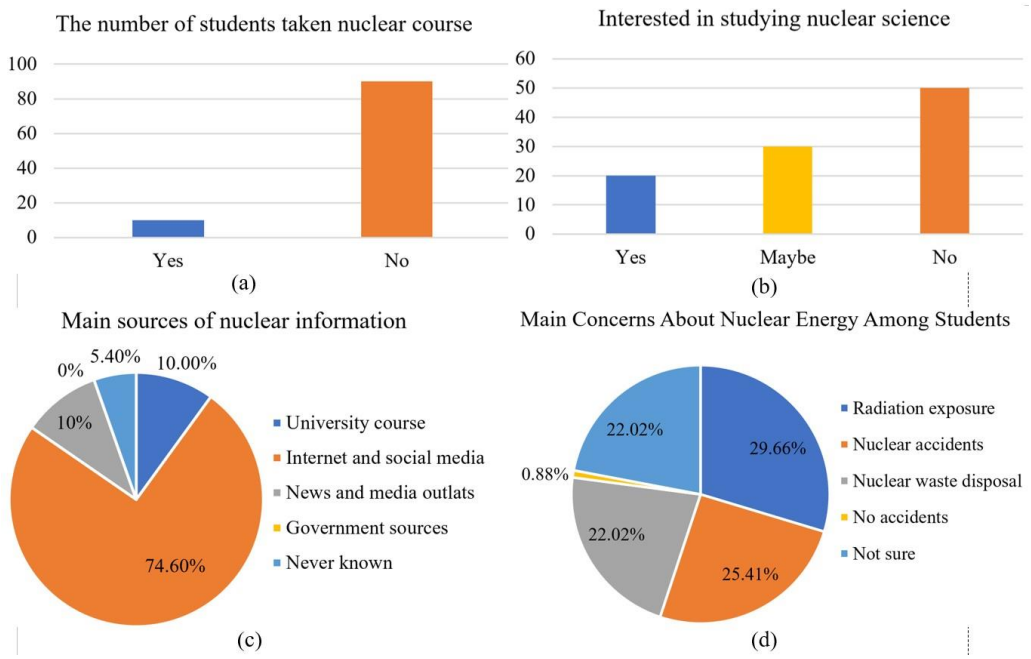

Figure 4 Survey results from engineering students regarding nuclear education and awareness in Cambodia

With the survey data in engineering students in Cambodia, as indicated in Figure 3, the survey results provide critical insights into the limited nuclear knowledge among engineering students in Cambodia. Despite being enrolled in technically oriented programs, the majority of students (over 90%) reported having no formal exposure to nuclear science or related subjects in their curriculum, as shown in Figure 3 (a). This lack of foundational knowledge stems largely from the absence of nuclear-focused courses in Cambodian universities, as well as a broader national gap in nuclear education infrastructure. Furthermore, when asked about the sources of information on nuclear energy and radiation, only 10% cited university coursework, while nearly 75% relied on internet and social media, as detailed in Figure 3 (c). This overreliance on informal, unverified sources suggests that much of students' understanding may be fragmented, superficial, or influenced by popular misconceptions. Although many students expressed interest in learning about nuclear science, their understanding of key concepts—such as the benefits, risks, and applications—remains limited. This is further reflected in their perceived risks, as indicated in Figure 3 (c): most students associate nuclear energy with radiation exposure, accidents, and waste disposal, which are valid concerns but often dominate public perception due to high-profile incidents rather than a balanced, science-based perspective. The lack of confidence and uncertainty among students is also evident in their survey responses, with a notable proportion answering “maybe” or “not sure” on questions related to both interest and safety perceptions. Collectively, these findings reveal that engineering students in Cambodia currently lack both structured education and scientific literacy in nuclear technology, even though they are among the most likely candidates to engage with the sector

in future careers. This highlights an urgent need to develop nuclear education modules, include basic nuclear physics and applications in engineering programs, and launch public outreach and training efforts to improve nuclear literacy at both institutional and national levels.

IV. Research Challenge

Although Southeast Asia has seen growing interest in the peaceful applications of nuclear technology—particularly in areas such as medicine, agriculture, energy planning, and environmental monitoring—disparities in nuclear research capacity remain significant across the region. This section focuses on the key research challenges faced by Cambodia and compares them with those of neighboring countries: Vietnam, Thailand, Laos, and Myanmar. The analysis highlights the structural, institutional, and strategic barriers that impede research development in nuclear science and technology.

Table 1 Status of Nuclear Infrastructure and Applications in Cambodia and neighboring countries

Countries	Research Reactors	Medical Applications	Industrial Applications	Agricultural Applications	Nuclear Power Plants
Cambodia [1], [12]	None	Yes	Yes	Yes	None
Vietnam [5], [13]	1 (Dalat NRR)	Yes	Yes	Yes	Planned (suspended 2030)
Thailand [9], [14], [15]	1 (TRR-1/M1)	Yes	Yes	Planned	Proposed
Laos [16], [17]	None	Limited	Limited	Limited	No
Myanmar [18], [19]	Planned (SMR)	Emerging	Emerging	Emerging	Proposed

Since becoming a member of the International Atomic Energy Agency (IAEA) in 1958, Cambodia has engaged in numerous nuclear-related activities, including signing international agreements, forming institutional frameworks, and establishing strategic partnerships with countries like Russia and China. These initiatives reflect a long-standing national interest in exploring peaceful nuclear technologies. However, despite these efforts spanning over six decades, Cambodia has yet to produce substantial results in nuclear research and development. The country still lacks essential infrastructure—such as a research reactor or nuclear academic programs—and has generated minimal scientific output in nuclear fields. This disconnect between diplomatic activity and research outcomes highlights a structural gap in Cambodia's nuclear strategy, where policy intent has not been matched by educational investment, human resource development, or research capacity-building. In contrast, Vietnam and Thailand each operate a research reactor (Dalat NRR and TRR-1/M1) and have proposed or planned nuclear power programs, as detailed in Table 1. Myanmar is progressing toward a Small Modular Reactor (SMR), and Laos, though limited in application, is developing capacity with international support. These countries also benefit from broader human resources, academic programs, and policy integration, which Cambodia currently lacks.

V. Discussion

To effectively bridge the nuclear knowledge gap in Cambodia, a strategic set of solutions must be implemented across short-, medium-, and long-term. In the short term, nuclear concepts should be integrated into high school science curricula and offered as elective modules or guest lectures at the university level, especially within engineering and science programs. Public outreach campaigns, supported by the Ministry of Education and international partners such as the IAEA or UNESCO, should also be launched to improve public understanding of nuclear energy and dispel common misconceptions. At the same time, targeted training workshops for university lecturers and science teachers can help build local capacity to introduce nuclear-related content into existing

courses. In the medium term, Cambodia should establish formal academic pathways—such as diploma programs or minors in nuclear science—at key institutions like ITC and RUPP. Expanding international scholarship opportunities and forming academic exchange programs with countries such as Vietnam, Thailand, Russia, and China can further accelerate human resource development. Additionally, the formation of a National Nuclear Education Taskforce composed of stakeholders from government, academia, and industry would provide coordinated oversight and strategic direction. In the long term, Cambodia should invest in establishing a national Center of Excellence for Nuclear Education and Research to support advanced studies, public engagement, and regional collaboration. This can lay the foundation for launching a full undergraduate program in nuclear engineering or radiation technology. Aligning these efforts with the United Nations Sustainable Development Goals (particularly SDG 4 on education, SDG 7 on clean energy, and SDG 9 on innovation and infrastructure) will ensure that nuclear education becomes a core component of the country's development strategy. Collectively, these solutions offer a practical roadmap for building Cambodia's future nuclear capacity through education, innovation, and international cooperation.

VI. Conclusion

Cambodia is at a critical turning point in its efforts to develop peaceful nuclear technology, with promising foundations in place through international partnerships, policy frameworks, and institutional commitments. However, the country continues to face a substantial gap in nuclear knowledge and human resource capacity, which significantly hinders its ability to adopt and benefit from nuclear technologies. This study has identified a range of interconnected challenges—from limited educational pathways and declining interest in science education, to a lack of trained professionals and insufficient research infrastructure. These barriers are particularly pronounced when compared with neighboring countries such as Vietnam and Thailand, which have made substantial progress in building nuclear education systems, research capacity, and technical expertise.

Survey results among Cambodian engineering students further emphasize the limited exposure to nuclear science, reliance on informal sources of information, and prevailing misconceptions about nuclear energy. At the same time, the expressed interest among students and general support for nuclear education reflect a strong potential to build national capacity if the right investments are made. Addressing these challenges requires a long-term, multi-dimensional strategy that includes curriculum development, public outreach, academic program creation, and international collaboration.

Ultimately, bridging the nuclear knowledge gap is not only a technical or educational concern—it is a strategic imperative for Cambodia's sustainable development. By fostering a well-informed and skilled workforce, supported by strong institutions and international cooperation, Cambodia can unlock the benefits of nuclear technology in energy, healthcare, agriculture, and industry. The time to act is now: with coordinated efforts and sustained investment, Cambodia can ensure a safe, informed, and forward-looking approach to its nuclear future.

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