IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 16, Issue 5 Ser. III (Sep. – Oct. 2026) 57-66
www.iosrjournals.org

The Imperative of Research and Training for the Personnel of the Atomic Energy Regulatory Authority in Bangladesh: A Strategic Alignment with IAEA Standards

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Abstract:
The sustainable development of nuclear energy programs in emerging countries largely depends on the strength, skilled workforce, and preparedness of their regulatory organizations. The Bangladesh Atomic Energy Regulatory Authority (BAERA) is the sole national body responsible for ensuring the safe, secure, and peaceful use of nuclear and radiological technologies in the country, supported by other necessary technical and nontechnical support organizations. Therefore, BAERA must strengthen its personnel's research capacity, human resources development activities, and training infrastructure, and align with international benchmarks set by the International Atomic Energy Agency (IAEA): the Fundamental Safety Principles, the Safety Standards, IAEA TECDOC publications, and the recommendations of the 2022 Integrated Regulatory Review Service (IRRS) mission. We aimed to assess Bangladesh's legal and institutional regulatory framework and trace its evolution from the Bangladesh Atomic Energy Commission (BAEC) to an independent regulatory regime under BAERA. By combining national legislation, inter-ministerial coordination structures, and IAEA-aligned training models, we propose a roadmap to build a resilient, knowledge based, independent regulatory authority. Key recommendations include adopting an outcome-based, systematic training approach, institutionalizing regulatory research, implementing knowledge management systems, and actively participating in international peer-review mechanisms. These measures could help BAERA become a robust, future-ready institution with sustainable regulatory infrastructure to oversee a complex and expanding nuclear and radiological infrastructure.

Keywords*: Training; Research; Regulatory Infrastructure; Regulatory body; Governance in developing country.*

Date of Submission: 11-10-2026 Date of Acceptance: 22-10-2026

I. Introduction

Bangladesh, an emerging nuclear energy-using nation, stands at a critical juncture in developing a robust, sustainable nuclear regulatory infrastructure. As nuclear energy presents both opportunities and complex challenges, establishing a competent, independent, and legally empowered regulatory authority is crucial. The Bangladesh Atomic Energy Regulatory Authority (BAERA), established under the Bangladesh Atomic Energy Regulatory Act (BAER Act) of 2012, marked a pivotal evolution from a promotional to a regulatory-focused approach in nuclear governance. This move aligns with the International Atomic Energy Agency's (IAEA) advocacy for separating promotional and regulatory responsibilities to avoid conflicts of interest and ensure impartial oversight[1,2].

The effectiveness of a nuclear regulatory body such as BAERA does not rest solely on the legal instruments under which it operates. It also depends on the scientific, technical, and administrative proficiency of its personnel and other regulatory instruments[3]. In a rapidly evolving nuclear landscape, continuous professional development, research-based decision-making, and adherence to international best practices are indispensable[4]. The increasing complexity of nuclear installations, exemplified by the ongoing development of the Rooppur Nuclear Power Plant (RNPP), demands that regulatory staff remain up-to-date with international safety standards, regulatory science, and risk management techniques[5].

This manuscript presents a comprehensive academic exploration into the legal and institutional frameworks shaping nuclear regulation in a developing country like Bangladesh. It traces the evolution from the Bangladesh Atomic Energy Commission's (BAEC) role to the establishment of BAERA, critically analyzes the inter-ministerial governance structure, and evaluates how the hierarchy of laws supports regulatory functions.

We also examine BAERA's core mandates, highlight technical and human resource gaps, and propose strategic interventions for capacity building and research engagement. The narrative is guided by IAEA documents such as the Fundamental Safety Principles (SF-1)[1], GSR Part 1 (Rev.1)[2], TECDOCs[4], and relevant Safety Report Series[5]. It also integrates graphical figures to support analysis of institutional relationships and regulatory responsibilities. Through this investigation, the paper aims to substantiate the argument that investing in human capital through research and structured training is a critical pillar for successfully implementing nuclear regulatory responsibilities in Bangladesh.

II. Legal and Institutional Framework of Nuclear Regulation in Bangladesh

This section explores the foundational legal and institutional structure that governs nuclear regulation in Bangladesh, illustrating the multilayered legislative process, historical development of regulatory institutions, and the interconnected nature of oversight mechanisms. The analysis is situated within the context of both domestic legislation and international obligations, particularly those stipulated by the IAEA[1,2].

1 Regulatory Hierarchy and Legal Evolution

Bangladesh's nuclear regulatory architecture follows a systematic hierarchy, consistent with international legal theory concerning nuclear oversight. This structure is illustrated in Figure 1 and consists of the following tiers:

- **Constitutional Level:** The Constitution of Bangladesh provides the overarching legal mandate for public safety, environmental protection, and the sustainable development of energy resources. Although it does not explicitly reference nuclear safety, it obliges the state to ensure citizens' well-being and conserve the environment—principles consistent with international nuclear safety norms[6].
- **Statutory Level:** The key legislation at this level includes the Bangladesh Atomic Energy Regulatory Act, 2012 (BAER Act 2012), which serves as the primary statute governing nuclear regulation. This act superseded earlier legislation, including the Nuclear Safety and Radiation Control Act, 1993. The BAER Act 2012 clearly delineates institutional responsibilities and provides the Bangladesh Atomic Energy Regulatory Authority (BAERA) with full legal authority over nuclear and radiological safety[7].
- **Regulatory Level:** This includes specific regulations like the Nuclear Safety and Radiation Control (NSRC) Rules 1997, which remain effective under Section 42 of the BAER Act 2012. These detailed instruments define procedures for licensing, inspection, radiation protection, and emergency response[7,8].
- **Guidance Level**: This level comprises non-binding documents such as safety guides, codes of practice, and technical manuals. These are frequently developed with reference to IAEA publications like TECDOCs and Safety Guides, and serve as interpretive aids to the legal and regulatory texts[4].

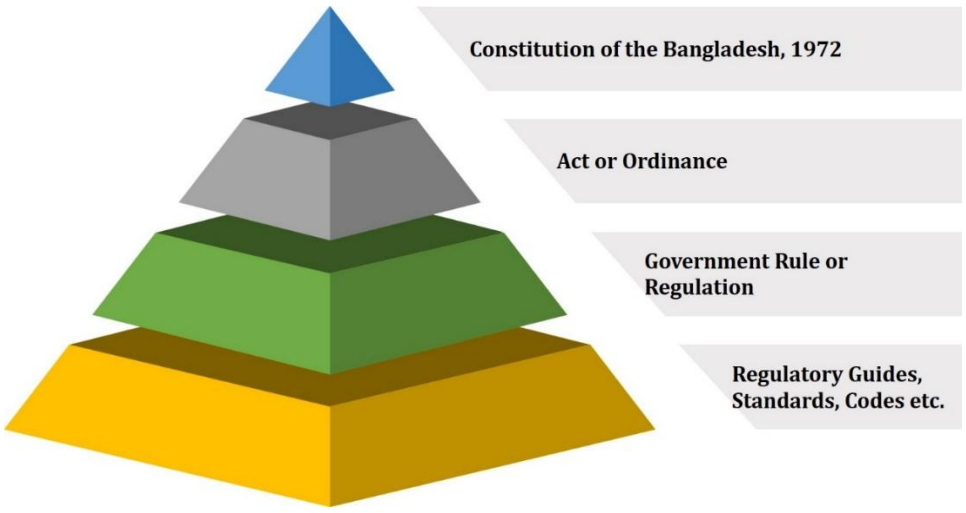


Figure 1. Hierarchy of the nuclear and radiological laws in Bangladesh.

This multi-tiered framework gives BAERA a clear, enforceable mandate to oversee nuclear activities. It ensures consistency with international safety standards and promotes regulatory transparency[1,4].

2 From BAEC to BAERA: Institutional Evolution

The Bangladesh Atomic Energy Commission (BAEC), established in 1973, initially held both promotional and regulatory functions concerning nuclear science and technology. While this dual mandate facilitated early-stage development, it gradually created conflicts of interest, especially as Bangladesh advanced its nuclear power agenda with the Rooppur Nuclear Power Plant (RNPP)[3,7].

To address this issue and align with IAEA recommendations, particularly the requirement for functional separation between promotional and regulatory bodies[1], the government enacted the BAER Act 2012. This legislation established BAERA as a legally independent regulatory authority responsible for licensing, inspection, enforcement, and radiation safety. BAEC retained its promotional functions, such as research and reactor operation, but lost all regulatory authority[3,7].

This separation aligns with international norms outlined in IAEA documents such as GSR Part 1 (Rev. 1), which emphasize the importance of independent regulation to avoid regulatory capture and ensure public trust[2]. BAERA's formation marks a significant institutional reform, reflecting Bangladesh's commitment to internationally accepted principles of nuclear and radiological governance[1,2,7].

3 Administrative Oversight and Inter-Ministerial Cooperation

Although institutionally independent, BAERA remains under the administrative purview of the Ministry of Science and Technology (MoST). However, effective nuclear governance requires a multisectoral approach. Figure 2 shows how ministries such as Health and Family Welfare, Environment and Forests, Law, and Defense interface with BAERA to ensure coherent, cross-cutting oversight.

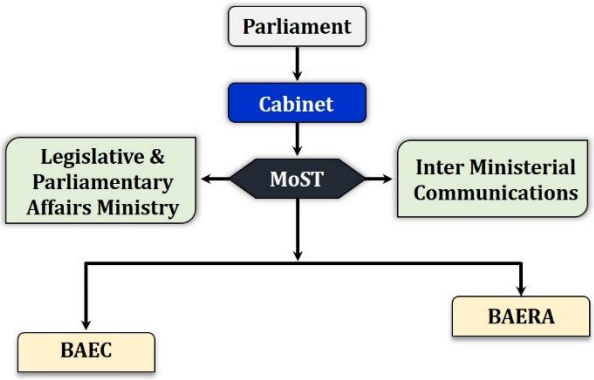


Figure 2. Structure of Bangladesh government related to nuclear energy and radiological affairs.

This structure supports consistent policy implementation and interagency coordination in emergency preparedness and response, radiation protection, enforcement, and the regulation of the transboundary transport of nuclear and radioactive materials. It reflects a governance model in which nuclear regulation transcends departmental boundaries to incorporate public health, environmental protection, national security, and legal compliance[3,7,8]. In addition, Bangladesh's legal and institutional framework for nuclear regulation shows a deliberate shift from centralized scientific control to decentralized, independent regulation. This evolution reflects adherence to international standards and equips Bangladesh with the institutional apparatus needed to manage its expanding nuclear program safely and effectively[1,2,4,7].

III. IAEA Guidance on Regulatory Competence

The IAEA recognizes regulatory personnel competence as a cornerstone of nuclear safety. The IAEA has developed an extensive body of normative guidance outlining expectations for regulatory bodies on training, capacity building, and competence development. These instruments include overarching safety principles, binding safety requirements, and detailed technical guidance. This section elaborates on the most relevant IAEA instruments and their implications for the BAERA.

1 Fundamental Safety Principles (SF-1)

The Fundamental Safety Principles (SF-1) document outlines ten principles that constitute the global safety philosophy for nuclear and radiological protection[1]. Among these, Principle 2 (Role of Government) asserts the state's responsibility to establish and maintain a legislative and regulatory framework for safety. Principle 3 (Leadership and Management for Safety) highlights that effective leadership and a strong safety culture are indispensable to regulatory performance. More specifically, Principle 8 (Prevention of Accidents)

and Principle 10 (Protective Actions to Reduce Existing or Unregulated Radiation Risks) emphasize the need for a trained and capable workforce to prevent accidents and mitigate their consequences effectively.

These principles stress the importance of human capital in regulatory effectiveness and call for continuous improvement through training, knowledge transfer, and institutional learning. For a country like Bangladesh, which is in the early stages of operating nuclear power plants, adherence to SF-1 is essential to build international credibility and ensure long-term sustainability in nuclear safety governance.

2 GSR Part 1 (Rev. 1): Governmental, Legal and Regulatory Framework for Safety

The General Safety Requirements Part 1 (Rev. 1) (GSR Part 1)[2] provides a comprehensive blueprint for establishing a national nuclear safety framework. Requirement 11 is particularly relevant, as it mandates that the regulatory body employ a sufficient number of qualified staff to fulfill its responsibilities effectively. It also requires structured education and training programs, knowledge management practices, and succession planning mechanisms to ensure organizational resilience.

GSR Part 1 (Rev. 1) also introduces Requirement 12, which focuses on competence management systems, periodic assessments of staff capabilities, and structured training to adapt to evolving technologies and safety standards. The IAEA recommends that member states adopt a graded training approach that prioritizes core competencies such as regulatory inspection, licensing assessment, emergency preparedness, and enforcement.

For BAERA, adopting these requirements offers a strategic path to strengthening regulatory functions. Establishing dedicated training programs aligned with IAEA guidance will help ensure regulatory decisions are based on sound technical judgment and scientific rigor.

3 TECDOCs and Supporting Instruments

Beyond normative safety principles and requirements, the IAEA provides detailed guidance through technical documents (TECDOCs) and safety reports. These tools are particularly valuable for implementing practical training systems within regulatory organizations.

- IAEA TECDOC-1254 describes the elements of a structured training program for regulatory bodies[9]. It emphasizes job-specific training plans tailored to distinct categories of personnel, such as regulatory inspectors, safety analysts, legal officers, and emergency coordinators. It also recommends periodic performance evaluations and role-specific certification requirements.
- IAEA TECDOC-1868 introduces the Systematic Approach to Training (SAT), which serves as a foundational methodology for developing, implementing, and assessing training programs. SAT includes five key stages: analysis, design, development, implementation, and evaluation. The document also recommends establishing Training and Qualification Programs (TQPs) for continuous professional development[4].
- Safety Reports Series No. 79 provides a toolset for conducting Self-Assessment of Regulatory Competence and Capability (SARCoN). This tool enables regulatory bodies to identify gaps in competence areas such as legal infrastructure, organizational structure, resource management, and stakeholder communication[5].
- Safety Guide SSG-44 offers phased guidance to states developing a nuclear power program. It emphasizes building regulatory competence at each phase, from the decision to embark on a nuclear program through plant commissioning and operation. It also calls for early development of a national strategy for education and training in nuclear safety[10].

IV. Functions of BAERA and Operational Requirements

As Bangladesh's nuclear program advances, BAERA has taken on an increasingly pivotal role in ensuring compliance with international safety standards and safeguarding public and environmental protection. To fulfill its mandate effectively, BAERA must have robust operational capacity, regulatory independence, and a technically proficient workforce. This section outlines BAERA's core functions, identifies existing capacity gaps, and examines the national regulatory instruments under which it operates.

1 Core Regulatory Functions

The BAER Act 2012 gives BAERA legal authority to regulate all nuclear and radiological activities in Bangladesh. The authority's core regulatory functions include authorization (license, permit, NOC etc.), inspection, enforcement, emergency preparedness, and public communication. Figure 3 illustrates these responsibilities by mapping BAERA's principal areas of regulatory engagement.

Each domain requires a high level of interdisciplinary expertise. For example, authorization entails reviewing safety analysis reports, environmental impact assessments, and probabilistic risk assessments tasks that demand engineering, radiological, and legal expertise. Inspection involves on-site evaluations of nuclear and radiological facilities and requires familiarity with instrumentation, radiation detection, and operational

procedures. Enforcement involves legal action and regulatory sanctions, which require comprehensive knowledge of administrative law and regulatory compliance mechanisms. Finally, emergency preparedness and response rely on coordination with multiple ministries and adherence to both national and international protocols[2,7].

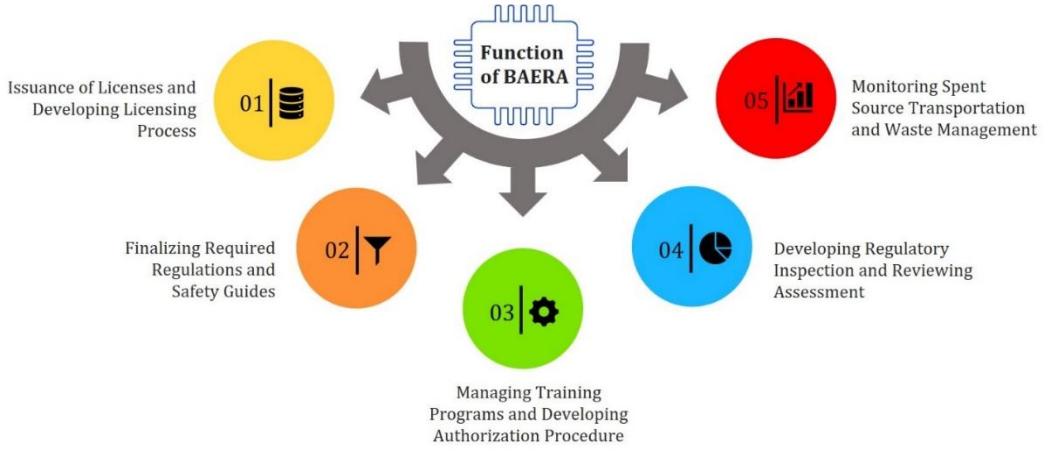


Figure 3. Functions of BAERA as competent authority

Without adequate technical knowledge and institutional capacity, these functions may remain procedural rather than substantive in practice. This underscores the critical importance of ongoing training and institutional learning for BAERA staff.

2 Human Resource and Technical Gaps

Despite notable progress in developing regulatory competence, BAERA continues to face significant skilled human resource challenges. Many staff members have received training in radiation protection and basic regulatory procedures. However, knowledge-skill gaps necessary for effective regulatory oversight persist in several critical areas, including:

- Reactor operations and safety analysis, particularly in the context of power reactors such as the Rooppur Nuclear Power Plant (RNPP).
- Cybersecurity, which is increasingly essential due to the digital integration of reactor instrumentation and control systems.
- Probabilistic Safety Assessment (PSA) and risk-informed regulations, which are crucial for modern, performance-based regulatory frameworks[4,5].
- Emergency preparedness and communication with considerable confidence, especially in multi-stakeholder scenarios involving the public, media, and first responders.

The IRRS Mission to Bangladesh (2022) highlighted the need for a long-term human resource development (HRD) strategy and recommended that BAERA adopt the Systematic Approach to Training (SAT) to build and sustain regulatory competence[3]. Furthermore, the mission emphasized the importance of knowledge retention and succession planning, given projected staff turnover, to meet the time-based increasing demands of Bangladesh's nuclear and radiological infrastructure.

To bridge these technical gaps, BAERA must institutionalize training programs aligned with IAEA TECDOC-1868 and implement internal knowledge management systems based on best practices from the Safety Report Series No. 79[5,9]. It must also collaborate with academic institutions to foster regulatory research and support graduate level education in nuclear safety disciplines.

3 Application of National Regulations

BAERA's regulatory authority has been operationalized through several national instruments, most notably the Nuclear Safety and Radiation Control (NSRC) Rules, 1997, which remain valid under Section 42 of the BAER Act, 2012[7,8]. These rules provide a detailed regulatory framework, including licensing procedures, operational safety standards, radioactive waste management, emergency measures, and penalties for non-compliance.

The NSRC Rules are broadly harmonized with the IAEA International Basic Safety Standards (BSS No. 115), which articulate the core requirements for radiation protection and safety of radiation sources[11]. In particular, the rules require:

- Authorization for the procure, produce, own, import, export, possess, use, transport, process, reprocess, market, transfer, move, store, abandon or dispose of any nuclear or radioactive material and/or any apparatus capable of producing ionizing radiation;
- Occupational exposure limits and personal monitoring;
- Environmental and public dose constraints;
- Emergency response planning and implementation;
- Enforcement actions, including suspension or revocation of licenses.

BAERA's ability to enforce these provisions depends heavily on the technical and legal competence of its inspectors, analysts, and legal officers. Therefore, capacity-building in legal interpretation, regulatory writing, and compliance auditing is critical to effectively implementing these rules[5,7,8].

V. Research Imperatives and Collaboration

Robust regulatory research is an essential pillar for any competent nuclear regulatory authority, enabling data-driven decision-making, adaptive policy responses, and innovation in safety oversight. For the Bangladesh Atomic Energy Regulatory Authority (BAERA), integrating structured research and international collaboration is vital to developing a forward-looking regulatory regime responsive to both domestic and global challenges. IAEA strongly emphasizes the importance of regulatory research as part of national safety infrastructure development, particularly for newcomer countries and those embarking on nuclear power programs[2,10].

1 National Regulatory Research Agenda

At present, BAERA lacks a formal in-house research wing focused on regulatory science. While BAERA conducts some ad hoc analytical work during licensing and inspections, the lack of a dedicated institutional structure limits its ability to anticipate and proactively address emerging regulatory issues. Establishing a national regulatory research unit within BAERA is therefore an urgent strategic priority, aligned with the IAEA's guidance in TECDOC-1868 and GSR Part 1 (Rev. 1), which stress the integration of research and knowledge development into regulatory processes[2,4].

The proposed research agenda should include, but not be limited to, the following domains:

- Modeling of severe nuclear or radiological accidents or incidents to support emergency preparedness and decision-making frameworks.
- Development of safety culture metrics to evaluate licensee compliance with behavioral and organizational safety standards.
- Environmental impact assessments (EIA) tailored to the Bangladeshi context, integrating coastal vulnerability, hydrological risks, and biodiversity concerns.
- Nuclear liability, insurance, and legal frameworks, including economic modeling of compensation schemes and alignment with international conventions such as the Vienna Convention on Civil Liability for Nuclear Damage.

These research initiatives would not only improve regulatory effectiveness but also build national expertise and capacity in nuclear governance. BAERA should establish formal partnerships with local universities, such as the University of Dhaka and Bangladesh University of Engineering and Technology (BUET), to build a pipeline of researchers and policy analysts specializing in nuclear safety and regulation.

Moreover, the IAEA's Knowledge Management for Regulatory Bodies (IAEA TECDOC-1510) highlights the importance of institutional learning through documentation, research archives, and digital knowledge-sharing systems[12]. Implementing these mechanisms would allow BAERA to retain institutional memory and reduce vulnerability to staff turnover or external disruptions.

2 International Collaborations

Active international collaboration is another essential element of regulatory development. BAERA's participation in international networks facilitates access to global best practices, comparative data, and technical assistance. The IAEA encourages regulatory bodies to engage in Coordinated Research Projects (CRPs) and collaborative forums to build capacity and support strategic learning.

BAERA's involvement in regional platforms such as the Asian Nuclear Safety Network (ANSN) and the Regulatory Cooperation Forum (RCF) has already laid a foundation for future collaborations. These forums allow regulators from Asia and beyond to conduct joint research, peer reviews, and technical exchanges on pressing issues such as reactor oversight, radiation protection, and radioactive waste management[13].

Engagement with regional networks such as the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) could also benefit BAERA through observer participation or bilateral cooperation agreements, even though Bangladesh is not a member. Such collaboration would expose BAERA to emerging

regulatory tools, including digital inspection systems, probabilistic safety assessment methods, and nuclear cybersecurity protocols[14].

Furthermore, BAERA should pursue formal agreements under the IAEA's Technical Cooperation (TC) framework to receive targeted support in launching research initiatives, acquiring simulation tools, and participating in IAEA-led training schools such as the International School of Nuclear and Radiological Leadership (ISNRL)[13,15].

VI. Training Strategy and Capacity Building

The effectiveness of a nuclear regulatory body like BAERA depends on its personnel's competence and preparedness. According to IAEA guidance, a sustainable, structured training system is critical to ensuring regulatory staff can address the evolving technical, legal, and operational demands of the nuclear sector[1,4,9]. This section outlines a comprehensive training and capacity-building strategy for BAERA based on international best practices, national needs, and recommendations from the 2022 Integrated Regulatory Review Service (IRRS) mission.

1 Institutionalizing the Training Function

To establish a systematic, sustainable training framework, BAERA should operationalize a National Regulatory Training Center (NRTC) within its organizational structure. The NRTC would serve as a permanent unit responsible for designing, delivering, and evaluating regulatory training programs. The IAEA's Education and Training Appraisal (EduTA) methodology supports this model by encouraging the creation of national training infrastructures[16].

The NRTC curriculum should follow the Systematic Approach to Training (SAT), which includes five core stages: training needs analysis, curriculum design, material development, training implementation, and impact evaluation[4,9]. The IAEA's TECDOC-1254 and TECDOC-1868 provide detailed training matrices that can be tailored to job-specific roles, such as licensing officers, safety assessors, and emergency coordinators[2,9]. Training frequency should be regular, with induction courses for new staff and periodic refreshers to keep pace with regulatory and technological developments.

2 Digital Platforms and E-Learning

Digital learning tools are increasingly vital for ensuring accessibility, flexibility, and personalization in capacity-building programs. BAERA should leverage platforms such as the Cyber Learning Platform for Network Education and Training (CLP4NET), developed by the IAEA, to facilitate remote and asynchronous learning[17]. These platforms support simulation-based modules for reactor oversight, radiation monitoring, and regulatory enforcement.

Incorporating AI-enhanced e-learning analytics, adaptive testing, and interactive scenario-based training can further improve learning outcomes. For example, virtual inspections and emergency response simulations offer immersive environments that build both technical skills and decision-making competencies. As recommended by the IAEA's TECDOC-1510 on knowledge management, digital tools should also support documentation, archiving, and institutional learning systems[12].

3 Fellowships and Academic Partnerships

Long-term competence development requires formal linkages between BAERA and higher education institutions. Partnerships with universities such as the University of Dhaka and Bangladesh University of Engineering and Technology (BUET) can help develop graduate curricula tailored to nuclear regulation, policy, and safety science. These partnerships should support dual-track career pipelines that combine academic education with practical regulatory experience.

Internationally, BAERA should expand participation in fellowships and leadership programs provided by the IAEA, World Nuclear University (WNU), KINS (Korea Institute of Nuclear Safety), and other bilateral cooperation mechanisms. These programs offer structured training in reactor safety, regulatory leadership, and nuclear law, and they expose regulatory staff to best practices in mature regulatory regimes[17,18]. Institutionalizing such fellowships within BAERA's HR policy would ensure equitable access and sustained impact.

4 Monitoring and Evaluation

Training effectiveness must be assessed continuously to ensure alignment with strategic objectives. According to IAEA TECDOC-1868, regulatory bodies should employ competency audits, impact evaluations, and Key Performance Indicators (KPIs) to track training outcomes[4]. Examples of performance indicators include improved inspection quality, reduced licensing delays, and increased participation in international peer reviews.

The IAEA's Safety Report Series No. 79 also recommends self-assessment frameworks for identifying gaps in regulatory competence and tracking improvements over time[5]. BAERA should develop a centralized training information management system to monitor staff progress, maintain training records, and support workforce planning.

5 IRRS Recommendations and Strategic Implications

The IAEA's IRRS Mission to Bangladesh in 2022 provided a comprehensive external evaluation of BAERA's legal, organizational, and functional capacity. The mission acknowledged BAERA's institutional commitment but identified gaps in human resources, training infrastructure, and strategic planning[3]. Specific findings included:

- Staffing levels at BAERA were insufficient to meet the demands of a full-scope regulatory authority overseeing a nuclear power program.
- There was no formal long-term human resource development plan aligned with regulatory needs and strategic goals.
- The systematic approach to training (SAT) was not consistently implemented across all personnel categories.
- Knowledge management and succession planning mechanisms were absent or underdeveloped.

The IRRS mission made several targeted recommendations to address these challenges:

- Develop and implement a long-term HRD plan that integrates training, recruitment, retention, and succession planning.
- Formalize the use of SAT in all training activities and align training programs with IAEA TECDOC-1254 and TECDOC-1868[2,9].
- Institutionalize a Human Resource and Knowledge Management Unit within BAERA to coordinate training, research, and staff development.
- Establish formal partnerships with international agencies to facilitate fellowships, technical exchanges, and participation in global peer review missions.
- Implement knowledge management systems for organizational learning and documentation.

These recommendations are vital to enhancing BAERA's regulatory maturity and ensuring its workforce is adequately equipped to manage the risks of a growing nuclear energy program. Adopting these, along with recommendations from other IAEA missions, such as the IPASS mission, will also align BAERA with global standards and improve its credibility in the international nuclear community.

VII. Knowledge Management and Succession Planning

In the context of nuclear regulatory bodies, effective knowledge management considered as not only essential for operational continuity but also for regulatory resilience. As personnel with specialized knowledge retire or transition, the loss of institutional memory can hinder organizational performance, effectiveness and regulatory credibility. Recognizing this risk, the IAEA has emphasized the critical role of knowledge management and succession planning in its technical documentation and advisory services.

IAEA TECDOC-1510 on Knowledge Management for Regulatory Bodies outlines strategies for systematically capturing, sharing, and preserving institutional knowledge across technical and administrative domains. In parallel, TECDOC-1556 offers guidelines specific to operating organizations, which are adaptable to regulatory authorities seeking to align with international standards of performance and knowledge retention[19].

To operationalize these guidelines, BAERA should adopt the following strategies:

- **Creation of an Internal Knowledge Repository:** This includes structured digital databases, procedural documentation, regulatory case studies, and legal interpretations. Such repositories should be accessible organization-wide and updated regularly to reflect evolving practices.
- Mentorship Programs: Experienced personnel can transfer tacit knowledge to newer staff through structured mentorship arrangements. These programs are particularly effective in building leadership capabilities and technical judgment among junior officers.
- **Exit Interviews and Knowledge Capture Mechanisms:** When experienced personnel retire or resign, formal debriefings should be conducted to document lessons learned, challenges faced, and recommendations for improvement. These interviews can be supported by digital tools that allow multimedia recording, tagging, and archiving.
- **Succession Planning:** Using workforce analytics, BAERA should identify critical positions and develop individualized development plans (IDPs) for potential successors. These plans should integrate formal training, job rotation, and academic advancement.

By institutionalizing these practices, BAERA will ensure that the knowledge base underpinning its regulatory decisions remains robust, current, and transferable. Furthermore, these systems can support organizational agility in the face of technological changes and regulatory expansion.

VIII. Strategic Recommendations

To build a forward-looking, resilient, and internationally credible nuclear regulatory framework, BAERA must implement an integrated set of capacity-building measures anchored in IAEA best practices. The following recommendations are synthesized from the findings of this study, IAEA guidelines, and the outcomes of the 2022 IRRS mission to Bangladesh.

- **Formulate a Comprehensive Training and Qualification Program (TQP)**
  BAERA should develop and institutionalize a TQP that encompasses all categories of staff technical, legal, administrative, and management. The program should be fully aligned with the IAEA's TECDOC-1868, incorporating the principles of the Systematic Approach to Training (SAT).
- **Establish a Research and Innovation Wing**
  A dedicated research unit should be created to undertake policy-relevant studies in regulatory science, including topics such as risk-informed decision-making, severe accident modeling, environmental risk assessments, and safety culture metrics. Collaboration with academic institutions and participation in IAEA Coordinated Research Projects (CRPs) is strongly encouraged.
- **Develop a Five-Years Strategic HRD Plan**
  Drawing on the IRRS 2022 and EduTA recommendations, BAERA must prepare a strategic Human Resource Development (HRD) roadmap. This plan should address recruitment, retention, diversity, skills forecasting, and succession management, aligned with both national needs and international benchmarks.
- **Utilize IAEA Peer Review Tools**
  Regular engagement with IAEA peer review instruments such as:
  a) SARCoN (Self-Assessment of Regulatory Competence and Capability),
  b) IRRS (Integrated Regulatory Review Service),
  c) EduTA (Education and Training Appraisal) etc.
  will allow BAERA to conduct periodic capacity audits, benchmark against global standards, and receive tailored recommendations for improvement.
- **Foster a Culture of Continuous Professional Development**
  BAERA should incentivize staff to engage in continuous learning through academic partnerships, international fellowships, and participation in global regulatory forums and conferences. These initiatives not only build individual expertise but also elevate the institution's global standing.

IX. Conclusion

The long-term credibility and effectiveness of Bangladesh's nuclear regulatory system depend on the capacity and competence of the Bangladesh Atomic Energy Regulatory Authority (BAERA). As Bangladesh becomes a nuclear power-generating country, the demands on its regulatory framework will grow considerably in scope and complexity. This study demonstrates an urgent need for a structured, forward-looking approach to training, research, and knowledge management within BAERA. By aligning with IAEA guidance, especially IAEA TECDOC-1868 and General Safety Requirements (GSR) Part 1, along with the 2022 IRRS mission's recommendations, Bangladesh can keep its regulatory infrastructure robust, resilient, and internationally credible. Four measures are essential to sustain regulatory excellence: adopting a systematic training approach, establishing a dedicated research unit, strengthening inter-agency collaboration, and investing in digital learning platforms. As BAERA develops into a knowledge-driven, future-ready sustainable regulatory authority, it will protect public health and the environment and strengthen Bangladesh's standing in the global nuclear community through significant, state-of-the-art, technology-based contributions.

Acknowledgments

The authors would like to thank the authority of the Bangladesh Atomic Energy Regulatory Authority (BAERA) for providing logistics during the study.

Conflict of Interest statement

The authors declare that there is no known conflict pertaining to this research work that may appear to influence this study.

References

[1]. International Atomic Energy Agency (IAEA), Fundamental safety principles. IAEA Safety Standards Series No. SF-1. Vienna: IAEA; 2006.
[2]. International Atomic Energy Agency (IAEA), Governmental, legal and regulatory framework for safety. General Safety Requirements Part 1 (Rev. 1). Vienna: IAEA; 2016.

[3]. International Atomic Energy Agency (IAEA), Integrated Regulatory Review Service (IRRS) report: Bangladesh. Vienna: IAEA; 2022.
[4]. International Atomic Energy Agency (IAEA), Managing regulatory body competence. IAEA-TECDOC-1868. Vienna: IAEA; 2018.
[5]. International Atomic Energy Agency (IAEA), Conducting a self-assessment of regulatory competence and capability. Safety Reports Series No. 79. Vienna: IAEA; 2014.
[6]. Ministry of Law, Justice and Parliamentary Affairs. Constitution of the People's Republic of Bangladesh. Dhaka: Government of Bangladesh.
[7]. Republic of Bangladesh Government. Bangladesh Atomic Energy Regulatory Act 2012, No. 19. Bangladesh Gazette 2012.
[8]. Republic of Bangladesh Government. Nuclear Safety and Radiation Control Rules-1997 (SRO No. 205-Law/97). Bangladesh Gazette 1997.
[9]. International Atomic Energy Agency (IAEA), Training the staff of the regulatory body for nuclear facilities. IAEA-TECDOC-1254. Vienna: IAEA; 2001.
[10]. International Atomic Energy Agency (IAEA), Establishing the safety infrastructure for a nuclear power programme. Safety Standards Series No. SSG-44. Vienna: IAEA; 2012.
[11]. International Atomic Energy Agency (IAEA), International basic safety standards for protection against ionizing radiation and for the safety of radiation sources. Safety Series No. 115. Vienna: IAEA; 1996.
[12]. International Atomic Energy Agency (IAEA), Knowledge management for regulatory bodies. IAEA-TECDOC-1510. Vienna: IAEA; 2006.
[13]. International Atomic Energy Agency (IAEA), Regulatory Cooperation Forum (RCF) and Asian Nuclear Safety Network (ANSN). Vienna: IAEA; 2022.
[14]. ASEAN Network of Regulatory Bodies on Atomic Energy. Regional safety initiatives and collaborative reports. Jakarta: ASEAN Secretariat; 2021.
[15]. International Atomic Energy Agency (IAEA), International School of Nuclear and Radiological Leadership (ISNRL). Vienna: IAEA; 2023.
[16]. International Atomic Energy Agency (IAEA), Education and Training Appraisal (EduTA) methodology. Vienna: IAEA; 2014.
[17]. International Atomic Energy Agency (IAEA), Cyber Learning Platform for Network Education and Training (CLP4NET). Vienna: IAEA; 2024. Available from: https://elearning.iaea.org.
[18]. World Nuclear University. Fellowship programmes. London: World Nuclear Association; 2024. Available from: https://world-nuclear-university.org/programmes/fellowship.
[19]. International Atomic Energy Agency (IAEA), Knowledge management for nuclear industry operating organizations. IAEA-TECDOC-1556. Vienna: IAEA; 2007.