

Bifurcated Compliance and the Compliance Facade Problem in the IAEA Nuclear Security Architecture

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Abstract

The International Atomic Energy Agency-led nuclear security governance architecture has substantially expanded since 2004, yet the persistence of significant non-state actor acquisition risk indicates that governance investment has not produced commensurate governance effectiveness. This paper investigates two interrelated structural sources of this divergence: the structural coherence limitations of the regime complex governing nuclear security, and the bifurcated compliance pattern that the architecture's near-exclusive reliance on assistance-based mechanisms generates. Drawing on a systematic analysis of 112 documents (treaties, IAEA Nuclear Security Series guidance, NTI Index data, and scholarly literature, 2004-2025) supplemented by five semi-structured expert interviews across four professional categories, the study applies regime complex theory (Raustiala and Victor, 2004) and three-mechanism compliance theory (Tallberg, 2002) to assess governance effectiveness. The findings document a three-stratum legal hierarchy in which the highest-authority instruments (UNSC Resolution 1540, the Convention on the Physical Protection of Nuclear Material) are the least technically specific, while the most technically specific instruments (the IAEA Nuclear Security Series) carry no formal legal authority generating what is termed the compliance facade problem. The compliance assessment confirms a bifurcated pattern: states with capacity-limited non-compliance respond effectively to IAEA assistance mechanisms, while states with strategic non-compliance remain unaddressed by the architecture's instruments. The paper develops three policy-relevant findings: that the structural-enforcement interaction generates a self-reinforcing weakness cycle that single-dimension reform cannot interrupt; that closing the formal-substantive compliance gap requires bridging the 1540 reporting framework and the IAEA Nuclear Security Series performance assessment; and that introducing oversight functionality through a graduated IPPAS accountability architecture is more politically feasible than introducing the litigation mechanism that Member States have consistently resisted. The paper offers recommendations for international policymakers, the IAEA Secretariat, and the UN Security Council 1540 Committee.

1. Introduction

Among the most consequential security challenges of the twenty-first century is the persistent risk that non-state actors will acquire nuclear or radiological material sufficient to construct an improvised nuclear device or a radiological dispersal device. The international community has responded to this risk with a substantial governance investment: the Convention on the Physical Protection of Nuclear Material (CPPNM, 1980; 2005 Amendment in force 2016), the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT, 2005), UN Security Council Resolution 1540 (2004), the four Nuclear Security Summits (2010-2016), the IAEA Nuclear Security Series (sixty-three guidance documents as of 2024), and the Global Initiative to Combat Nuclear Terrorism (2006) collectively represent an architecture of unprecedented institutional density. Yet two decades of empirical assessment by the Nuclear Threat Initiative Nuclear Security Index, the IAEA's own Annual Reports on Nuclear Security Activities, and academic specialists have documented persistent and systematic gaps between the standards the architecture establishes and the governance performance it actually generates.

This paper investigates the structural sources of this gap. Two analytical questions guide the investigation. First, does the IAEA-led nuclear security architecture, as a regime complex, exhibit structural coherence limitations that systematically undermine its effectiveness? Second, does the architecture's particular compliance mechanism profile comprehensive assistance, limited oversight, absent litigation generate a predictable bifurcated compliance pattern that leaves the most strategically significant gaps unaddressed? Both questions are addressed empirically through systematic analysis of the governance documentary corpus (112 documents spanning 2004 to 2025) and analytically through application of regime complex theory and three-mechanism compliance theory. The findings have direct implications for nuclear security reform: they identify which structural reforms are most likely to produce governance improvement, and which are unlikely to overcome the architecture's most fundamental limitations.

The paper proceeds as follows. Section 2 reviews the relevant theoretical literature on regime complexes, hard and soft law instruments, and compliance mechanism design in international institutions. Section 3 specifies the research objectives. Section 4 describes the systematic methodology applied to documentary analysis and expert interview integration. Section 5 presents the findings on structural coherence and compliance bifurcation, organised through the analytical framework. Section 6 concludes with policy implications and recommendations for further research.

2. Literature Review

2.1 The Regime Complex Framework for Nuclear Security Governance

Raustiala and Victor (2004) introduced the concept of the "regime complex" to describe international governance domains characterised by overlapping institutional authority, parallel rather than hierarchical legal instruments, and the absence of an integrating institutional framework. The nuclear security domain exemplifies this institutional architecture: the IAEA, the UN Security Council 1540 Committee, INTERPOL's Radiological and Nuclear Terrorism Prevention Unit, the United Nations Office of Counter-Terrorism (UNOCT), and the now-dormant Nuclear Security Summit process all operate on overlapping mandates without an integrating institutional framework. Regime complex theory predicts three governance limitations in such architectures: forum shopping (states selectively engaging with mechanisms that demand the least), normative inconsistency (different instruments specifying different requirements for similar issues), and accountability gaps at institutional boundaries (no single institution accountable for cross-cutting failures). Each of these predictions has been investigated in the nuclear security context, though no prior study has applied the integrated three-prediction framework systematically across the architecture's entire instrument set.

Abbott and Snidal (1998) offer the complementary hard/soft law typology that explains why regime complexes typically combine binding instruments with non-binding standards. Their framework predicts that in security-sensitive domains where states are reluctant to accept binding obligations, governance architectures will tend toward soft-law instruments that achieve broad participation at the cost of

weaker enforcement. The IAEA Nuclear Security Series sixty-three technically detailed but legally non-binding documents is paradigmatic of this design choice. The hard/soft law tension is the structural source of what Doyle (2013) terms the "compliance facade problem": states can satisfy the formal legal obligations of binding instruments through legislative activity that does not require conformance with the technically specific standards in non-binding guidance.

2.2 The Compliance Theory Foundation

Tallberg (2002) provides the most influential framework for analysing how international institutions generate compliance from their member states. His three-mechanism framework distinguishes litigation (binding dispute settlement with consequences for non-compliance), oversight (monitoring, reporting, and transparency mechanisms), and assistance (capacity-building and technical support). Each mechanism has distinct theoretical effectiveness profiles: litigation is most effective against deliberate strategic non-compliance but requires strong enforcement authority; oversight is effective against inadvertent non-compliance but requires reliable information access; and assistance is effective against resource-constrained non-compliance but cannot address states that choose non-compliance for strategic reasons. The framework predicts that institutions that lack one or more mechanisms will experience predictable patterns of compliance failure for the cases that the missing mechanism would otherwise address.

Tallberg's framework intersects with the broader managerial-versus-enforcement debate in international compliance scholarship. Chayes and Chayes (1993) argue that most international non-compliance is inadvertent and best addressed through managerial mechanisms (transparency, capacity-building, dialogue). Downs et al. (1996) counter that state behaviour reveals substantial strategic non-compliance that managerial approaches cannot address, and that effective international institutions therefore require enforcement mechanisms with credible consequences. The empirical reality of nuclear security governance extensive technical capacity-building yet persistent strategic non-compliance by states with the means but not the will to implement standards represents the compliance dilemma in its most consequential form.

2.3 The Compliance Facade Problem in Nuclear Security

The phenomenon of states satisfying formal legal compliance requirements while failing to demonstrate substantive governance performance has been documented across the nuclear security literature. Walker (2011) argues that the voluntary character of IAEA nuclear security governance reflects deliberate political choice favouring state sovereignty over governance effectiveness. Acton and Willman (2012) provide the most systematic programmatic assessment of the IAEA's nuclear security work, documenting both its technical sophistication and its structural limits. Bunn and Sagan (2020) demonstrate that the gap between compliance reporting and operational security performance is the most consequential single weakness in the architecture, particularly for states whose civilian nuclear programmes are large enough to generate governance reporting requirements but whose strategic

posture makes them resistant to substantive accountability. Flynn (2024) reframes the compliance facade as a "layered accountability gap" requiring structural rather than merely procedural reform.

The literature converges on a critical assessment: that the assistance-heavy IAEA architecture generates substantial governance improvements where capacity is the binding constraint, and almost no governance improvement where strategic considerations are the binding constraint. The bifurcated compliance pattern that this institutional profile generates has been documented but not systematically analysed in terms of what reform would close the gap. This paper contributes to the literature by addressing precisely this question.

2.4 Empirical Assessment Frameworks: The NTI Nuclear Security Index

The NTI Nuclear Security Index (NTI, 2023) provides the most comprehensive empirical framework for assessing national nuclear security performance. The Index assesses states across multiple dimensions including domestic nuclear material security commitments, regulatory framework quality, physical protection arrangements for nuclear facilities, and risk environment characteristics. The Index documents persistent and significant disparities in national nuclear security performance, with a substantial gap between leading states (Australia, Canada, Switzerland, the Netherlands, Belgium, the United Kingdom) and a tail of states whose performance has improved minimally despite extensive IAEA assistance (NTI, 2023). The bifurcated pattern that NTI documents corresponds precisely to the theoretical prediction of three-mechanism compliance theory: assistance generates improvement where capacity is the binding constraint; strategic non-compliance remains unaddressed.

3. Objectives

The objectives of this study were to:

- i. Assess the structural coherence of the IAEA-led nuclear security architecture as a regime complex, applying Raustiala and Victor's (2004) framework and Abbott and Snidal's (1998) hard/soft law typology;
- ii. Document the architecture's three-stratum legal hierarchy and analyse the inverse relationship between binding force and technical specificity that constitutes the structural source of the compliance facade problem;
- iii. Assess the compliance mechanism inventory of the IAEA-led architecture against Tallberg's (2002) three-mechanism framework, documenting the structural asymmetry of comprehensive assistance, limited oversight, and absent litigation;
- iv. Document the bifurcated compliance pattern that the architecture's mechanism profile generates, distinguishing capacity-limited non-compliance (effectively addressed by assistance mechanisms) from strategic non-compliance (not addressed by any current mechanism); and

v. Develop policy-relevant recommendations for closing the compliance facade gap and introducing oversight functionality without requiring the litigation mechanism that Member States have consistently resisted.

4. Methodology

This study employed a systematic mixed-methods qualitative research design combining structured documentary analysis with expert interview corroboration. The methodological design followed PRISMA (Page et al., 2021) protocols for the documentary component and established expert interview standards (Tansey, 2007; Harvey, 2011) for the qualitative component. The combined methodology was selected because nuclear security governance assessment requires both the systematic coverage that documentary analysis provides and the practitioner contextual knowledge that expert interviews provide.

4.1 Documentary Corpus Construction

A documentary corpus of 112 governance documents was constructed through systematic application of inclusion and exclusion criteria across the 2004-2025 study period. The PRISMA selection process began with 947 candidate documents identified through structured database searches (Web of Science, Scopus, Google Scholar) and institutional repository searches (IAEA, UN, NTI, Belfer Center, Vienna Center for Disarmament and Non-Proliferation). After title and abstract screening (947 to 804 documents), full-text screening for substantive relevance (804 to 231 documents), and final eligibility assessment against analytical inclusion criteria (231 to 112 documents), the final corpus comprised: IAEA Nuclear Security Series guidance documents (33 documents); UN Security Council resolutions and 1540 Committee reports (18 documents); NTI Nuclear Security Index editions and methodological documentation (8 documents); peer-reviewed journal articles in nuclear security, non-proliferation, and international security (32 documents); institutional reports from Belfer Center, VCDNP, RAND, and similar (14 documents); and treaty texts and depository status reports (7 documents).

4.2 Coding and Analytical Framework

The 112-document corpus was coded against a deductive coding framework comprising fourteen codes organised in three analytical dimensions. The structural coherence dimension comprised five codes (SC-01 through SC-05) covering legal hierarchy, coverage gaps, boundary conditions, forum shopping, and normative inconsistency. The enforcement capacity dimension comprised four codes (EC-01 through EC-04) covering compliance mechanism inventory, compliance gap patterns, accountability architecture, and engagement-performance divergence. The institutional adaptability dimension comprised five codes (IA-01 through IA-05) covering threat assessment timeliness, governance revision timelines, illicit trafficking adaptation, insider threat adaptation, and emerging threat adaptation. Inter-rater reliability was established through independent coding of a 22-document subsample (20 per cent of the corpus) by two coders, with Cohen's kappa values ranging from 0.78 to 0.85 across the fourteen codes all within Landis and Koch's (1977) "substantial agreement" range and several within the "almost perfect" range.

4.3 Expert Interview Integration

To corroborate documentary findings and surface practitioner knowledge not available in published sources, five semi-structured expert interviews were conducted across four professional categories: Category A (current/former IAEA official with safeguards inspection experience, n=1), Category B (senior policymaker and senior military strategist with national nuclear security policy responsibilities, n=2), Category C (academic specialist in nuclear security governance, n=1), and Category D (technical policy expert with cybersecurity expertise relevant to nuclear infrastructure, n=1). Interview protocols followed semi-structured design (Galletta, 2013), with a core question set ensuring comparability across participants and discretionary follow-up questions enabling depth on category-specific expertise. Member checking (Birt et al., 2016) was applied: all five participants reviewed both their interview transcripts and the analytical findings derived from them.

4.4 Ethical Considerations

The study was conducted under the institutional research ethics framework of the National Defence University of Malaysia, with informed consent secured from all interview participants prior to engagement and confidentiality protections specifying institutional category-level identification rather than individual identification in any published output. The documentary corpus consists entirely of publicly available sources. Interview transcripts are retained under institutional ethics protocols. Ethical compliance statement: this study was conducted in accordance with the institutional research ethics guidelines of the National Defence University of Malaysia (Universiti Pertahanan Nasional Malaysia, UPNM). Under those institutional guidelines, formal ethics committee approval was not required for this non-interventional, minimal-risk study involving semi-structured interviews with professional experts speaking in their professional capacity, and the need for formal ethics committee approval was accordingly waived; no protocol number is therefore applicable. This waiver under UPNM research ethics policy was confirmed by the candidate's main doctoral supervisor, Dr. Azrul Azlan, Faculty of Defence Studies and Management, UPNM. Freely given informed consent was obtained from all participants prior to their engagement.

5. Results and Discussion

5.1 The Three-Stratum Legal Hierarchy and the Compliance Facade Problem

The first principal finding documents the IAEA-led nuclear security architecture's three-stratum legal hierarchy and the inverse relationship between binding force and technical specificity that this hierarchy generates. The first stratum comprises universally binding instruments adopted under UN Charter Chapter VII authority principally UN Security Council Resolution 1540 (2004) and Resolution 2325 (2016) which are binding on all 193 UN Member States. These instruments achieve universal legal authority but are formulated at substantial generality: Resolution 1540 requires states to adopt "appropriate effective laws" to prohibit non-state actor acquisition of weapons of mass destruction and related materials, but

neither specifies what "appropriate and effective" means operationally nor designates the IAEA Nuclear Security Series as the benchmark against which adequacy is assessed (United Nations, 2004).

The second stratum comprises multilateral treaty instruments principally the CPPNM (1980), the CPPNM Amendment (2005, in force 2016), and ICSANT (2005, in force 2007) that establish more specific legal obligations but achieve only partial universality. As of 2025, 164 states are parties to the CPPNM and 123 to ICSANT, while the CPPNM Amendment has 130 states parties meaning that approximately one-third of the original CPPNM's parties have not yet extended Convention scope to domestic civil nuclear material and facility sabotage protection (IAEA, 2025). The treaty stratum is more legally specific than the universal stratum but generates governance gaps for non-parties and scope gaps even for parties.

The third stratum comprises the IAEA Nuclear Security Series sixty-three guidance documents organised hierarchically from Nuclear Security Fundamentals through Recommendations and Implementing Guides to Technical Guidance. The NSS provides the most technically specific governance content in the entire architecture: it specifies particular physical protection performance requirements, operational security procedures, and material accounting and control protocols. However, the NSS is non-binding: states are not legally required to implement its standards unless specifically referenced in national legislation or bilateral arrangements with the IAEA.

The structural problem this hierarchy generates is that the instruments with the highest formal legal authority are the least technically specific, while the instrument with the highest technical specificity has no formal legal authority. States can therefore satisfy the technically vague obligations of the highest-authority instruments through legislative activity that does not demonstrate conformance with the technically specific NSS standards. This gap between formal legal compliance and substantive governance performance constitutes the compliance facade problem first identified by Doyle (2013) and confirmed empirically across the documentary corpus.

The expert interview evidence corroborated this documentary finding across all four participant categories. A Category A participant (current/former IAEA official) observed that "states report 1540 implementation in legal-formal terms 'we have a Nuclear Security Act, we have an Atomic Energy Authority' without engaging with the question of whether their protection systems actually meet the technical performance standards in NSS-225." A Category B participant (senior policymaker) characterised the implementation gap directly: "The NPT and Resolution 1540 lay fundamental grounds, yet adherence depends on the national implementation to a high extent. There are states which are not capable or willing enough to implement these measures entirely, creating major vulnerabilities." These observations converge on the analytical point: formal compliance and substantive performance are systematically dissociable in the current governance architecture.

5.2 The Compliance Mechanism Inventory: Tallberg's Framework Applied

The second principal finding documents the compliance mechanism profile of the IAEA-led architecture and the structural asymmetry between mechanism categories. Application of Tallberg's (2002) three-mechanism framework documents that the architecture comprises a comprehensive assistance dimension, a structurally limited oversight dimension, and a completely absent litigation dimension. Litigation mechanisms instruments through which states can be made subject to binding non-compliance findings with consequences are wholly absent from the architecture: no instrument or institutional body has authority to make binding non-compliance findings or to impose consequences for nuclear security governance failure. Oversight mechanisms instruments providing monitoring, reporting, and transparency are present but structurally limited: 1540 reporting depends on state self-reporting without verification; IPPAS peer reviews are conducted only at state invitation and do not produce findings binding on the host state; and no aggregate compliance reporting authority exists. Assistance mechanisms are comprehensive: the IAEA's Integrated Nuclear Security Support Plan (INSSP) programme covers more than ninety states; the Nuclear Security Series provides technical guidance across all major operational domains; and the IAEA's training infrastructure (including the Seibersdorf laboratories) is technically sophisticated and well-resourced.

The asymmetry is precisely the architecture Proposition 2 (the architecture's bifurcated compliance prediction) identifies as generating the bifurcated compliance pattern. Tallberg (2002) demonstrates across multiple governance domains that assistance-only architectures however technically sophisticated systematically fail to generate compliance from states whose non-compliance is not caused by capacity limitations but by political calculation. The nuclear security architecture is the assistance-only case par excellence: it has built the most sophisticated international nuclear security assistance programme available, and there is extensive evidence that this programme is effective for its design purpose. The architecture's predictable limitation is precisely what Tallberg's framework predicts: it cannot address strategic non-compliance because it has no mechanism that imposes costs on strategic non-compliance.

5.3 The Bifurcated Compliance Pattern: Empirical Evidence

The third principal finding documents the bifurcated compliance pattern empirically across the 2010-2024 NTI Nuclear Security Index time series. The NTI Index documents two distinct compliance trajectories: a substantial cluster of states (most notably Kazakhstan, Georgia, Romania, and Bulgaria) whose nuclear security scores have improved consistently across the period, with these improvements directly attributable to IAEA assistance through the INSSP programme; and a smaller but strategically significant cluster of states whose scores have remained stable or improved only marginally despite documented IAEA assistance engagement. The first cluster represents the assistance mechanism's effective domain states with capacity-limited non-compliance whose engagement generates measurable improvement. The second cluster represents the architecture's predictable failure domain states whose non-compliance is not addressed by the assistance mechanism because the binding constraint is not capacity.

The Pakistan case illustrates the analytical point. According to publicly available sources, Pakistan has a developed nuclear regulatory infrastructure the Pakistan Nuclear Regulatory Authority (PNRA) is a functioning regulatory body with technical expertise, established physical protection standards, and international engagement through the IAEA's technical cooperation programme (NTI, 2023; Bunn, 2006). Pakistan is a party to the CPPNM and has an active INSSP. In several technical governance dimensions documented in the public record regulatory framework quality, material accounting and control system documentation, and physical protection standard setting Pakistan's governance performance has been consistent with that of a state at its regulatory development tier. Yet the gap between Pakistan's formal compliance profile and its substantive governance performance remains contested in the published assessment literature, illustrating the architecture's broader pattern: formal compliance is achievable, substantive performance assessment is constrained by the architecture's mechanism limitations.

The IPPAS engagement-versus-performance differential provides quantitative confirmation of this pattern. The 12-percentage-point gap between CPPNM Amendment ratification (80 per cent of relevant states) and IPPAS mission hosting (68 per cent of relevant states) demonstrates that the most accessible accountability mechanism formal treaty ratification is satisfied at substantially higher rates than the most demanding accountability mechanism peer review hosting. The 42-percentage-point gap between initial IPPAS mission completion and follow-up IPPAS mission completion demonstrates further: states that have engaged IPPAS at the most visible stage do not follow through to the stage that requires demonstrating adaptation implementation.

5.4 The Structural-Enforcement Interaction Effect

The fourth principal finding documents the interaction between the structural coherence and enforcement capacity dimensions. The compliance facade problem (the gap between formal legal compliance and substantive performance, generated by the structural coherence of the legal hierarchy) is operationalised by the absence of oversight mechanisms (the enforcement capacity gap). If the architecture had robust oversight mechanisms mandatory verification, public aggregate compliance reporting, comparative performance metrics the compliance facade would be measurable and politically costly to maintain. Because the architecture has only voluntary peer review and self-reporting, the facade is sustained without political cost. Conversely, if the architecture had no compliance facade problem if formal legal compliance and substantive performance were tightly coupled the absence of oversight mechanisms would be less consequential because formal compliance would itself measure substantive performance.

This interaction effect has direct implications for reform sequencing. Reforms that address only the structural coherence dimension (for instance, by introducing performance-linked reporting requirements) without simultaneously strengthening oversight capacity will achieve limited governance improvement, because the enforcement gap will allow the new performance requirements to be satisfied formally without substantive implementation. Reforms that address only the enforcement dimension (for instance, by strengthening IPPAS follow-up requirements) without addressing the underlying structural

coherence problem will be politically resisted, because the compliance facade currently provides political cover for states resistant to substantive accountability. Effective reform requires coordinated intervention across both dimensions.

5.5 Policy Implications

The findings generate three policy-relevant recommendations. First, a formal performance linkage between UN Security Council Resolution 1540 reporting and IAEA Nuclear Security Series conformance would close the compliance facade gap at its most accessible point: 1540 reporting is the most universally observed accountability mechanism in the architecture, and using it to create expectations of NSS performance documentation would generate governance pressure that the current unconditional reporting framework does not create. The reform does not require treaty renegotiation, does not impose binding new obligations, and does not require Security Council action beyond the existing 1540 Committee operating framework. Its political feasibility is moderate but achievable through soft-norm incremental development.

Second, a graduated IPPAS accountability architecture replacing the current uniform peer review framework with a three-tier structure differentiated by accountability intensity would introduce oversight functionality without requiring the litigation mechanism that Member States have consistently resisted. The graduated structure would enable states to engage with the architecture at the level commensurate with their substantive readiness, while creating progressive accountability for states whose engagement remains at the lowest tier despite extended programme participation.

Third, a formal safeguards-security information sharing protocol within the IAEA enabling cross-functional information flow between the safeguards function (which has independent verification authority) and the nuclear security function (which lacks it) would address the internal IAEA boundary condition that currently prevents the architecture from leveraging its single independent verification authority to support its security mandate. This reform lies within the IAEA Director General's existing authority and is the most immediately achievable of the three.

6. Conclusion

This paper has documented two interrelated structural sources of the gap between the IAEA-led nuclear security architecture's governance investment and its governance effectiveness: the structural coherence limitations of the regime complex governing nuclear security, and the bifurcated compliance pattern that the architecture's mechanism profile generates. The compliance facade problem the systematic dissociation of formal legal compliance and substantive governance performance is the central structural finding. The bifurcated compliance pattern the architecture's effectiveness against capacity-limited non-compliance and its inability to address strategic non-compliance is the central enforcement finding. The interaction between the two dimensions generates a self-reinforcing weakness cycle that single-dimension reform cannot interrupt. The paper has developed three policy recommendations targeting the most accessible reform leverage points, each designed to introduce

governance functionality without requiring the politically infeasible mechanism categories that Member States have consistently resisted.

Future research should investigate three priorities: first, the empirical assessment of comparative governance architectures (the Chemical Weapons Convention's Organisation for the Prohibition of Chemical Weapons, the comprehensive safeguards system) to identify which structural design features could be transferred to nuclear security governance; second, the political economy of nuclear security reform, including the conditions under which Member States historically resistant to oversight mechanisms have accepted incremental accountability strengthening in adjacent governance domains; and third, the development of soft-norm accountability mechanisms that operate within existing legal authority but generate governance pressure equivalent to that which formal litigation mechanisms would provide.

Declarations

Funding:

The authors declare that no funding was received for conducting this study.

Clinical trial number: not applicable.

Data availability

The datasets generated and/or analysed during the current study are not publicly available due to the confidentiality protections applying to expert interview transcripts but are available from the corresponding author on reasonable request. The documentary corpus analysed in this study consists of publicly available treaty texts, IAEA publications, performance index data, and published scholarly literature, all of which are cited in the reference list.

Ethical Approval and accordance

In accordance with the institutional guidelines of the National Defence University of Malaysia (UPNM), formal ethics committee approval was not required for this study, which involved non-interventional, minimal-risk semi-structured interviews with professional experts speaking in their professional capacity. The research was carried out in accordance with those institutional guidelines.

Consent to participate

Freely given, informed consent to participate in the study was obtained from all interview participants prior to their engagement. All participants were adults and professional experts participating in their professional capacity.

Consent to publish

Informed consent to publish was obtained from all interview participants. No identifying personal information is included in this manuscript; all interview material is presented in anonymised form.

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