Strengthening Transport Safety of Radioactive Material through Standardization and Conformity Assessment: Indonesia Challenges and Opportunities

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Abstract

The safe transport of radioactive material requires robust regulatory systems, standardization, and accredited conformity assessment bodies (CABs). Indonesia has adopted several regulations [6] [18] and national standards [11–15], yet faces critical challenges in aligning with updated international standards such as IAEA SSR-6 Rev.1 [1] and the quality management system standard SNI ISO 19443 [16][18]. Currently, only three CABs operate (one Certification Body and two Testing Laboratories), and there is no Management System CB under the scope of SNI ISO 19443 [Table1]. Furthermore, standards ISO 2919, ISO 12807, ISO 9978, ISO 7195, and ISO 1496-1 [2][3][8-10] have yet to be adopted into national standard and conformity assessment scopes. This creates a significant gap in implementing quality assurance and regulatory compliance [1].

Standardization contributes between 0.3% and 1% annually to a country's GDP [19][20]. Indonesia has initiated national roadmaps and inter-agency coordination strategies [4][5] to address these gaps. A comparative analysis of ASEAN and selected countries [Fig.3][Table 2] reveals varying maturity in integrating technical regulations, standards, and conformity infrastructure. Standardization and Conformity Assessment (SCA) and CABs are vital for safety, quality, competitiveness, and regulatory recognition [17]. Of 96 identified potential CABs (18 CBs, 10 TLs, and 86 MS CBs) [Fig.2] [Table 1], their development is essential to meet national SCA needs. International benchmarking, harmonization, capacity building are key strategies to support Indonesia's safe, standards-based transport system for radioactive materials.

Keywords: radioactive material transport, standardization, conformity assessment, Indonesia, SSR-6, ISO, CABs

Key Challenges in Indonesia

The implementation of international standards and conformity assessments is essential for transport safety. Indonesia faces key challenges: (1) regulatory misalignment with SSR-6 Rev1 and related standards, and (2) limited accredited CABs and testing facilities in the radioactive transport sector.

Standardization and Conformity Assessment (SCA) and CABs Mapping

SCA play a critical role in supporting economic growth, enhancing competitiveness, facilitating market access, and ensuring safety, health, and environmental protection. Studies (ISO, OECD) indicate that standardization contributes between 0.3% and 1% annually to a country's GDP, depending on the level of adoption and integration into national regulatory frameworks [19][20]. Moreover, internationally accredited CA has been shown to build global market trust, streamline cross-border trade, and strengthen compliance with safety standards [21][22]. The World Bank (2023) emphasizes that strengthening quality infrastructure, including CABs, is a key factor in driving sustainable industrialization and trade in developing economies [23]. Conversely, the absence of international standards in regulations and limited accredited CABs can undermine competitiveness and regulatory oversight [24].

Conformity Assessment is an activity to assess that Goods, Services, Systems, Processes, or Individuals have met the reference requirements[7] as figure 1.

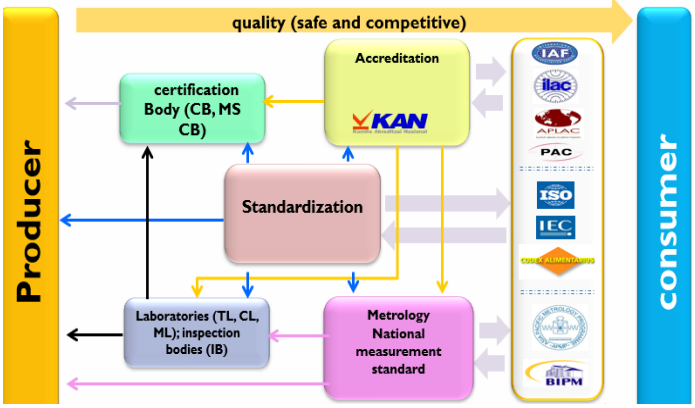

Figure 1. Indonesia SCA

Table 1. CABs Mapping

Conformity Assessment Body (CAB)	Number and scope of CABs	the number of potential KAN-accredited CABs to be developed the scope
Certification Body (CB), ISO/IEC 17065	Radiant Heater Product	Electronic products, electricity, electronics, electrotechnics, EMC
	1	18
Test Laboratory (TL), ISO/IEC 17025	Radioactive sources, packaging	Devices/products that generate emissions/radiation
	2	10
Management System Certification body (MS CB), ISO/IEC 17021	SNI ISO 19443, quality management standard specifically designed for the nuclear industry	MS CB for Quality Management System (SNI ISO 9001)
	0	68
TOTAL (July 2025)	3	96

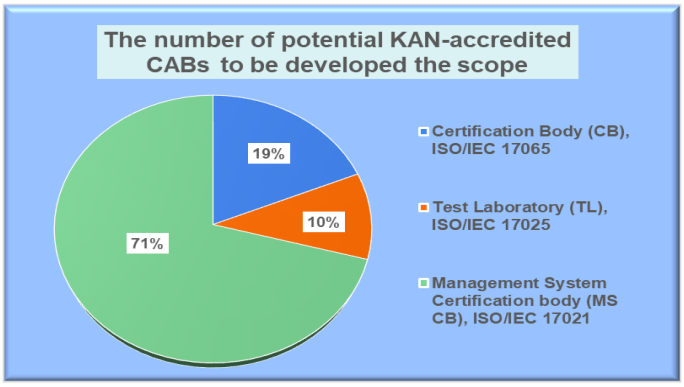

Figure 2. Mapping potential CABs

Indonesia currently has three CABs, one Certification Body (CB) and two Testing Laboratories (TL), but no Management System CBs (MS CBs) under the SNI ISO 19443 scope to support Standardization and Conformity Assessment (SCA). This limited availability creates gaps in regulatory [1] and quality assurance standard implementation. Furthermore, ISO 2919, ISO 12807, ISO 9978, ISO 7195, and ISO 1496-1 have yet to be adopted, with no CABs operating under these scopes. To address this, 96 potential CABs, comprising 18 (19%) CBs, 10 (10%) TLs, and 86 (71%) MS CBs could be developed. Strengthening CAB capacity is essential to support Indonesia's strategic plan [4][5].

Indonesia has regulations [18] that regulate the nuclear energy utilization facilities and activities management system, the implementation of which can be harmonized with the integration of international standards [16] to expand global acceptance through SCA activities by institutions accredited by the National Accreditation Committee (KAN).

Country Readiness Assessment and Comparative Study

Regulatory alignment (adoption of IAEA SSR-6 standards), CAB Capacity with accreditation (ILAC MRA), infrastructure (availability of certified packaging, vehicles, inspection/testing facilities), human resources training programs and certification systems and digitalization (e-licensing, digital tracking, and data systems) are dimensions in this chart

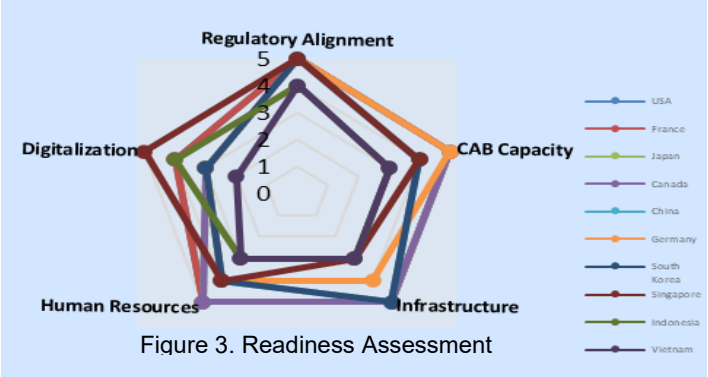

Figure 3. Readiness Assessment

The chart shows several examples of developed countries that have matured in considering the five aspects in their policies. Indonesia and in general ASEAN countries are at the "Developing" to "Emerging" stage, in terms of readiness for the safe transportation of radioactive materials.

The following table provides a comparative overview of economy in terms of regulatory frameworks, institutional leadership, and key standards, along with challenges and types of conformity assessment applied in the safe transport of radioactive materials

Table 2. Comparative Study

Country		Standards	Regulation	Main Challenges	Improvement Actions	Conformity Assessment
USA[A][*]	NRC, DOT, DOE	ANSI N43.6 (2919), ANSI N14.1 (12807), ANSI N14.5 (9978), ANSI N14.6 (7195), ANSI MH5.1 (1496-1); SSR-6 integrated in 10 CFR 71	NRC RG 7.10 (2020), 10 CFR Part 71	Multi-agency coordination	Digital licensing modernization	NRC & DOT certification inspection
Canada[A][*]	CNSC, Transport Canada	CAN/CSA ISO 2919, 12807, 9978, 7195, 1496-1; SSR-6 via PTNSR (SOR/2000-208); CSA N286, ISO 9001	CNSC Packaging and Transport of Nuclear Substances Regs	Remote logistics	Coordination with provinces	CNSC licensing, CSA assessments
South Korea[#]	KINS, MOTIE	KS ISO 2919, 12807, 9978, 7195, 1496-1; SSR-6 via Nuclear Safety Act (revised 2020); ISO 19443, ISO 9001	Nuclear Safety Act Revision	Design complexity	Technical training, digital tools	KINS & vendor certification
Japan[B][@]	NRA, JNES	JIS Z 4511, 4513, 4514, 4515, 4520 (aligned with ISO 2919–1496-1); SSR-6; ISO 19443, ISO 9001	NRA Ordinance on Transportation of Nuclear Fuel	Aging nuclear workforce	e-Licensing, succession policy	NRA-based licensing & QMS inspection
China[Y]	NNSA, MEE	GB/T 10244, 12941, 14583, 14584, 1413 (ISO 2919–1496-1 equivalents); SSR-6 via GB 11806-2004; ISO 19443, ISO 9001	Regulation on Safe Transport of Radioactive Material	Provincial enforcement gap	Training, licensing centralization	NNSA certification & safety review
Germany[A]	BfS	DIN ISO 2919, 12807, 9978, 7195, 1496-1; SSR-6 integrated via EU ADR; ISO 19443, ISO 9001	ADR 2023 (European Agreement on Transport of Dangerous Goods)	SME compliance cost	SME certification support	BfS & EU Notified Body approval
France[A] [@]	ASN, ANDRA	NF ISO 2919, 12807, 9978, 7195, 1496-1; SSR-6 via ASN Decision 2019-DC-0665; ISO 19443, ISO 9001	ASN Decision No. 2019-DC-0665	Aging workforce	Education & training program	ASN & ANDRA testing & certification
Indonesia	BAPETEN, BSN, KAN, MoT	SNI ISO 2919:2020, 12807:2015, SNI ISO 19443:2022, ISO 1496-1:2013; SSR-6 adopted via BAPETEN 7/2020	BAPETEN Regulation No. 6/2023, BAPETEN 7/2020	SSR-6 gaps, limited CABs	Roadmap, CAB accreditation, HR development	KAN certification, BAPETEN verification

Country		Standards	Regulation	Main Challenges	Improvement Actions	Conformity Assessment
Singapore[Y]	NEA, EDB	SS ISO 2919, 12807, 1496-1; SSR-6; ISO 9001	Radiation Protection Act 2007	Foreign logistics dependence	National logistics & tracking	NEA-authorized inspection
Vietnam[B]	VARANS, MOST	SSR-6 via Circular 19/2012/TT-BKHCN; Referenced ISO 2919, 12807, 1496-1; QMS via IAEA GSR Part 2	Circular 19/2012/TT-BKHCN (implements SSR-6)	Foreign reliance, limited labs	IAEA cooperation & bilateral support	VARANS-managed licensing

Most countries assessed have adopted ISO standards (2919, 12807, 9978, 7195, 1496-1) through national equivalents, with SSR-6 fully integrated[A] and partial alignment remains[B]. Regulatory frameworks vary in maturity. Indonesia has Regulation No. 7/2020 and adopting SSR-6 (2012). Common challenges include limited CAB capacity[B], fragmented inter-agency coordination[*], technical complexity[#], and workforce aging[@] also face logistics and enforcement constraints[Y]. Key improvement strategies involve digital licensing, CAB capacity building and international training. Conformity assessment systems led by national bodies vary in strength and shows the need for SCA strategic expansion is important to ensure standard, regulatory compliance and international recognition.

Conclusion & Limitations

National strategic are need to be align with national laws, regulations and standards, expand CAB accreditation scope in radioactive transport, digitalize tracking and supervision systems, enhance human resources through internationally-based training, promote international and regional collaboration for benchmarking and harmonization[Figure 3].
Most countries assessed [Table 2] have adopted ISO standards, SSR-6 Rev1 and have common challenges in limited CAB capacity, fragmented inter-agency coordination, technical complexity, workforce aging, face logistics and enforcement constraints. Conformity assessment systems led by national bodies vary in strength. Indonesia's limited CAB capacity—three active bodies and no MS CBs under SNI ISO 19443 [Table1, figure 2] — creates critical gaps in implementing standards and regulations [1]. Key international standards (ISO 2919, 12807, 9978, 7195, 1496-1) remain unadopted, with no accredited CABs in these scopes. Developing 96 identified potential CABs is essential to strengthen national SCA and support strategic regulatory goals [4][5].

Indonesia is moving toward a safer, standards-compliant radioactive material transport system. International lessons are vital to strengthening SCA infrastructure. The limitations is access to comprehensive data on scope CABs is limited, and inconsistencies in how countries document and report. This studi focuses on SCA, without covering operational incidents or enforcement outcomes in detail. The radar chart are based on qualitative synthesis, which while informed, may not fully reflect ground-level realities in each country. Further research is needed to assess operational effectiveness of SCA implementation in term of the safe transport of radioactive materials

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[8] ISO 12807 Safe transport of radioactive materials — Leakage testing on packages

[9] ISO 9978 Radiation protection — Sealed sources — Leakage test methods

[10] ISO 7195 Nuclear energy — Packagings for the transport of uranium hexafluoride (UF6)

[11] SNI 18-6937-2002 – Zat radioaktif: Pembungkus – Uji kebocoran isi dan radiasi

[12] SNI ISO 3925:2015 – Zat radioaktif tidak terbungkus – Identifikasi dan dokumentasi

[13] SNI ISO 17874-1:2012 – Peralatan penanganan jarak jauh untuk bahan radioaktif – Persyaratan umum

[14] SNI IEC 62244:2016 – Instrumentasi proteksi radiasi – Portal monitor radiasi untuk deteksi bahan nuklir/radioaktif di perbatasan

[15] SNI 18-6650.2-2002 – Proteksi radiasi – Sumber radioaktif tertutup – Metode uji kebocoran

[16] SNI ISO 19443:2018 Sistem manajemen mutu - Persyaratan khusus untuk penerapan ISO 9001:2015 oleh organisasi dalam rantai pasokan pada sektor energi nuklir yang memasok produk dan jasa yang penting bagi keselamatan nuklir

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