QETCI
Quantum Ecosystems Technology Council of India

Mapping Value Across Quantum: How India's Quantum Value Chain Framework Is Reshaping Global Policy

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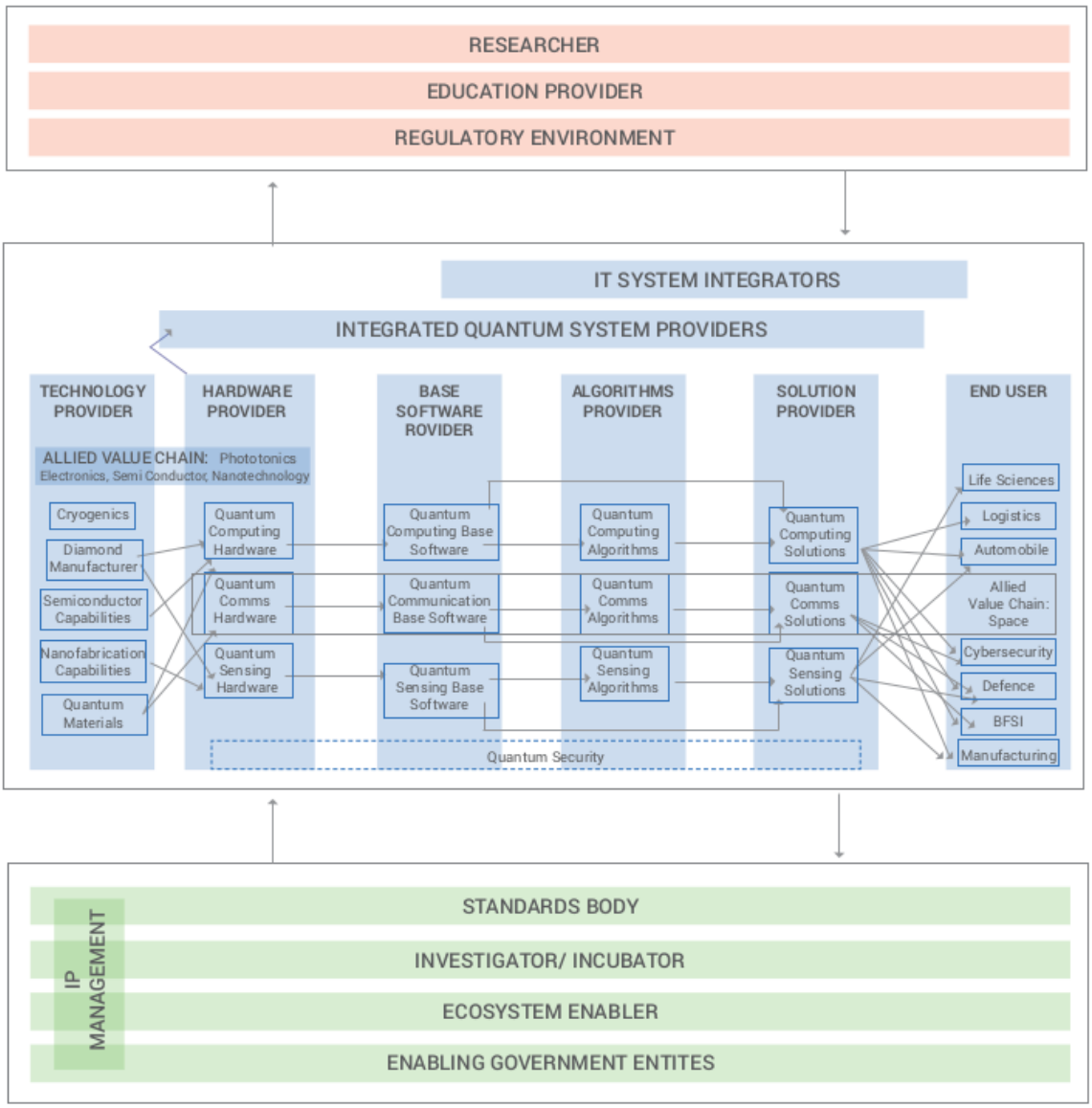
April 2026

When the Quantum Ecosystems Technology Council of India (QETCI) set out in 2023 to understand India's quantum landscape, it encountered a fundamental problem. No framework existed to capture how value actually flows through a quantum technology ecosystem. Supply chain analyses had been attempted elsewhere, but several key stakeholders were being left out. The quantum ecosystem was too multidimensional for a simple linear supply chain model to contain. The answer was to build something new.

The result, published in December 2023 at the National Quantum Science and Technology Symposium (NQSTS) co-organised with India's Ministry of Electronics and Information Technology (MeitY), was the Quantum Value Chain Report (ETGovernment, 2023). At its core was the Quantum Value Chain Framework, which provides a structured lens for mapping how value is created, transformed, and transferred across the full quantum ecosystem, from raw material and component suppliers, through hardware and software developers, to end-user applications, while also capturing the non-supply-chain forces that shape the ecosystem, such as research and development, manpower and skilling, intellectual property, standards development, and international collaboration.

The framework is visualised in three-tiers (QETCI, 2023). At the top sit the upstream enablers, including researchers, education providers, and the regulatory environment, whose outputs feed into the core value chain but are not part of it in the conventional supply chain sense. The central tier maps the primary flow of commercial value from technology providers supplying cryogenics, quantum materials, semiconductors, and nanofabrication capabilities, through hardware providers building quantum computing, communication, and sensing systems, to base software and algorithms layers, and finally to solution providers who package these into deployable products. End users span sectors including life sciences, cybersecurity, defence, BFSI, logistics, and manufacturing. Cutting horizontally across this central tier is quantum security, acknowledging that it is not a discrete product category, but a concern embedded throughout the stack. Overarching the entire central tier are IT system integrators and integrated quantum system providers, who coordinate across multiple layers. Below the core, a fourth horizontal layer captures the ecosystem's institutional scaffolding, including standards bodies, incubators, ecosystem enablers, and enabling government entities, and IP management.



Rather than treating quantum as a technology product moving along a pipeline, the Quantum Value Chain Framework situates every stakeholder, including startups, academia, government bodies, investors, and multinationals, within a web of interdependencies. It then superimposes a national context onto this global template, making it possible to identify where a country's ecosystem is strong, where it is weak, and where strategic intervention is most needed. Alongside the framework, the report introduced a "Current State of the Quantum Value Chain" diagnostic diagram, enabling a direct visual assessment of a nation's performance across each vertical of the chain.

For policymakers, this framework offers a data-grounded basis for decision-making in an otherwise opaque domain. For industry, it illuminates supply chain gaps and collaboration pathways. For academia, it clarifies where research effort could be

most productively directed. And for international partners, it provides a shared vocabulary for discussing bilateral and multilateral quantum cooperation.

The framework has since travelled well beyond its origins. NITI Aayog's 2025 ***Roadmap for Transforming India into a Leading Quantum-Powered Economy*** directly adopted the framework as a lens for understanding the overall quantum supply chain, using its current-state diagram to assess the performance of key verticals (NITI Aayog, 2025).

The World Economic Forum's 2024 ***Quantum Economy Blueprint*** cited it as a case study in the value of national self-assessment under Theme 1, illustrating how such analyses can surface opportunities, weaknesses, and strategic options (WEF, 2024).

Centre for International Governance Innovation (CIGI) published a report titled ***Quantum Technologies and Situational Awareness: The G7 and Beyond***, which mentions referring to it for SWOT analysis (Forrest *et al.*, no date).

The Principal Scientific Advisor (PSA) to the Government of India's report titled ***India's International Technology Engagement Strategy (ITES) for Quantum*** office released a report that draws upon QETCI's value chain report for a list of universities in India that offer Quantum Science and Technology Initiatives (QSTI) courses, as well as companies specialising in quantum education within the country (PSA, 2025).

Telangana Quantum Strategy Framework for Research, Skilling, Innovation and Economic Growth, a report by the Government of Telangana, India relied on the value chain framework for the creation of its quantum strategy. The value chain framework was used to define the core operational dimensions and pillars of engagement. Strategic interventions were then applied across these pillars to establish Telangana as an integrated quantum innovation center. This center was set to be characterised by international competitiveness, industrial relevance, and long-term strategic autonomy and resilience for national security. (Government of Telangana, 2025)

WEF's ***Piloting The Quantum Economy Blueprint: Lessons From Saudi Arabia*** highlighted the necessity of a unified framework for assessing quantum readiness. It utilised the value chain framework, specifically by conducting a value chain analysis, operationalising the World Economic Forum's (WEF) quantum economy blueprint, enabling the mapping of quantum initiatives to national missions. Furthermore, its operational lesson 1 emphasised the significance of this value chain analysis. (WEF, 2026)

Unveiling the Indo-Dutch Quantum Frontier: In Search of Opportunities to Integrate Ecosystems utilised the framework to identify areas of collaboration across various domains and explore potential synergies and opportunities for collaboration in quantum technology between India and the Netherlands (QETCI, 2025).

Similarly, at the **India Global Forum**, QETCI formalised a **UK-India collaboration** around a value chain mapping using the framework.

Both the Indo-Dutch and UK-India projects show how the framework can be used as infrastructure for bilateral quantum diplomacy, an application beyond its use as a domestic analytical tool. This is perhaps the most consequential application in the near future, since shared value chain mapping exercises could support technology partnership agreements with far greater concreteness than the general commitments that currently characterise quantum diplomacy.

Report	**How Value Chain Framework is Utilised**
Niti Aayog Roadmap for Transforming India into a Leading Quantum-Powered Economy	Adopted the framework to assess the quantum supply chain and vertical performance.
QETCI Indo-Dutch Report	Builds up on the framework to analyse the countries quantum maturity for possible areas of collaborations
PSA's Report International Technology Engagement Strategy Quantum	Referred to the list of universities and companies providing quantum education
WEF's Quantum Economy Blueprint	Highlighted as best practice for self-assessment and national strategy development.
CIGI's Quantum Tech and Situational Awareness report	Referred to the framework for SWOT analysis
WEF's Piloting The Quantum Economy Blueprint Lessons From Saudi Arabia	Used the framework to analyse the quantum readiness and operationalising WEF's quantum economy blueprint.
Telangana's Quantum Strategy	The strategy is built upon the value chain framework

The framework also has a role in export control and strategic trade policy, a domain that is growing in importance as quantum hardware edges toward dual-use status. By making the structure of the value chain legible, the framework helps policymakers identify which nodes are strategically sensitive, which are genuinely open, and where chokepoints exist that could be exploited by adversarial actors.

As national quantum missions mature and industrial-scale quantum hardware becomes commercially relevant, the pressure on governments to understand their domestic value chains, and their vulnerabilities within global ones, will only

intensify. The value chain framework could play an important role in iterative national benchmarking. In the context of India, the framework already provides a structured basis for tracking whether gaps identified in 2023 are being closed, and where new vulnerabilities are emerging. A periodically updated value chain assessment could serve as a national quantum health check, analogous to the kind of competitiveness indices that guide investment and industrial policy in other sectors.

QETCI has acknowledged from the outset that the framework requires periodic update as the technology evolves. The next iteration of the Quantum Value Chain Report, whenever it comes, will land in a very different landscape, one where the framework has already been validated by some of the most consequential quantum policy documents of the decade, and where the question is no longer whether such a framework is needed, but how finely it can be calibrated to guide the decisions that determine the future.

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