POLICY BRIEF

Quantum Sandboxes for the Majority World: A Dual Governance Approach to Innovation and Regulation

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Digital Transformation

Abstract

Quantum technologies have the power to transform sectors ranging from cryptographic security to climate modelling and sustainable infrastructure, creating valuable opportunities for Majority World countries to engage and benefit, generating unique economic opportunities – or leading to increased technological inequalities. Due to the lack of predictable and incremental advancements, caused by the highly uncertain trajectory of the technology with multiple possible technological solutions and shifting timelines, long-term regulatory planning through structured governance is challenging. Sandboxes offer a structured yet flexible environment for experimentation, particularly in contexts where strict regulations and a lack of interoperability have hindered innovation.

This policy brief proposes a dual governance approach that integrates experimentation to ensure agile yet responsible quantum technology development. An operational quantum sandbox would help Majority World countries explore the technology and its applications, similar to crypto and artificial intelligence (AI) sandboxes. It can later transition into a regulatory sandbox once risks and applications are identified. This approach serves both as a framework for agile quantum regulation and as a catalyst for leveraging the technology in problem-solving, taking into account the unique challenges posed by the technology's specifics.

By emphasising measurable, individualised action items, the brief will highlight the intersection of quantum technologies with other emerging fields such as neuroscience and generative AI. It will also assess the capacities required for their initial implementation and explore potential avenues for collaboration with countries that have greater access to quantum technology than those in the Global South.

Keywords: Quantum Technologies, Regulatory Sandboxes, Inclusive Innovation, Anticipatory Governance, Emerging Technology Policy

Diagnosis

Quantum technologies promise to address some of today's most pressing challenges – ranging from climate change to next-generation medical devices. While in their early stages, these technologies are recognised as transformative tools by major international institutions such as the G20,[1] OECD[2] and UN.[3] Their potential extends beyond scientific novelty; they are widely viewed as strategic assets that will shape the future of economic competitiveness, security, and innovation.

Despite their promise, quantum technologies risk deepening global inequalities. Many low- and middle-income countries face barriers such as limited infrastructure and restrictive regulations. These challenges threaten to exclude them from the next technological wave, widening the existing gap in innovation and participation.

In line with G20 priorities and Sherpa Track deliberations, the South African G20 presidency has stressed the importance of leveraging digital technologies for inclusive development.[4] To support this goal, we recommend deliberately integrating quantum technologies into the G20 digital agenda to support overcoming inequalities. This brief outlines how regulatory sandboxes tailored for quantum can foster inclusion and equitable participation in emerging ecosystems, while providing clear and practical mechanisms to advance this objective.

[1] John Potter, "US and India Strengthen Quantum Ties," *IoT World Today*, 2023.
[2] OECD, *A Quantum Technologies Policy Primer*, *OECD Digital Economy Papers*, no. 371 (OECD Publishing, 2025)
[3] Jing Zhao, "UNESCO: Quantum Science and Technology," *UN Today*, March 1, 2025, https://untoday.org/unesco-puts-the-spotlight-on-quantum-science-and-technology/./
[4] G20. *Issue Note – Digital Economy Working Group*. G20 India Presidency, 2024. https://g20.org/wp-content/uploads/2024/12/Issue-Note_Digital-Economy-WG-1.pdf

The early stage of quantum development presents a chance to build inclusive, resilient governance. Instead of traditional regulation, guardrails and sandbox environments can help manage risks and guide innovation. Quantum sandboxes, supported by public–private partnerships and phased models, enable testing of technologies and policies, fostering global participation and governance that reflects diverse regional and technical perspectives.

A major challenge governing quantum technologies' ability to address inequality lies in the concentration of expertise in elite academic institutions and well-funded corporations in high-income countries. To counter this imbalance, it is essential to foster broad, cross-sector collaboration. Governments, civil society, and diverse actors from the public and private sectors must be included in discussions shaping quantum technology's future. Without meaningful representation from underrepresented regions, the emerging regulatory landscape risks replicating – and deepening – existing technological divides.

Quantum technologies are technically not comparable to "traditional" disruptive technologies – they are converging technologies that integrate with existing systems. This introduces complex legal and technical challenges, including interoperability with current infrastructure, unclear intellectual property frameworks, and cross-border data governance. Policymakers must draw on lessons from other converging technologies like artificial intelligence (AI) to develop adaptive governance models that can respond to quantum's evolving and interconnected nature.[5] Integrating these lessons to address both local and regional challenges will be vital to fulfilling the G20's goal of fostering inclusive, sustainable development and bridging the technological gap between nations.

[5] Venkatesh Kulothungan and Deepak Gupta, "Towards Adaptive AI Governance: Comparative Insights from the U.S., EU, and Asia," in *Transforming the Business of Government: Insights on Resiliency, Innovation, and Performance*, ed. M. J. Keegan and D. Chenok (Lanham, MD: Rowman & Littlefield Publishers, 2024)

Early involvement of public authorities – including regulators, policymakers, and standards-setting bodies – is critical in shaping the trajectory of quantum technologies responsibly.[6] Concurrently, to safeguard the pace and effectiveness of innovation it is imperative to establish adaptive frameworks for stakeholder engagement that are compatible with the iterative and agile nature of technological development. However, representatives of Majority World countries are often underrepresented, and the specific problems of these regions often stay undetected. The lack of participatory and inclusive environments can have long-lasting consequences for the countries themselves and the rest of the world.

One promising mechanism to address these challenges is the use of regulatory and technical sandboxes. These are controlled environments where emerging technologies can be tested for compliance with existing regulations – or used to pilot new ones. Sandboxes provide a structured yet adaptable space to collaborate on innovation while managing risk.

A key advantage of sandboxes over other policy experimentation tools is their ability to convene stakeholders and allow for limited risk-taking in a safe, managed environment. This enables testing of advanced solutions under real-world conditions. In other settings, it is often difficult to achieve meaningful coordination or to integrate multiple perspectives. By contrast, sandboxes strike a productive balance that bridges regulatory and technical domains while fostering collaboration across sectors.

Given the complexity and transformative potential of quantum technologies, traditional sandbox models must evolve. A quantum sandbox should be a hybrid environment that integrates both technical and regulatory experimentation. It must support testing for security, performance, and interoperability while also

[6] Deloitte Center for Government Insights with the Council on Competitiveness, *Revisiting the Government's Role in Catalyzing Modern Innovation* (Deloitte Insights, 2023).

allowing regulatory bodies to prototype legal and ethical frameworks tailored to quantum's unique characteristics.[7]

The following proposed model of a "quantum sandbox" is aligned with the G20's development goals and tailored to the needs of Majority World countries. It outlines key features a dual-purpose quantum sandbox must include to serve as a sustainable and inclusive governance tool.

Recommendations

The proposed model begins as a technical sandbox that includes innovators from the outset, enabling early experimentation with quantum technologies in real-world conditions but in a safe regulatory space. While regulators and policymakers are engaged early, their role in shaping the sandbox's direction intensifies over time. Political and societal stakeholders would initially engage to understand the technology's technical aspects and later assess the impact of existing or proposed policies and standards on its development and deployment.

For instance, a cybersecurity research unit within a university might launch a quantum communication sandbox, involving national cybersecurity agencies. These agencies would gain firsthand experience with the technology, experimenting with the application of existing cybersecurity standards. Offering shared governance and clearly defining roles based on participants' expertise, the sandbox helps reduce information asymmetries and promotes cooperative problem-solving.[8]

[7] Paula Ganga, "Quantum Technology Challenge: What Role for the Government?" in *Transforming the Business of Government: Insights on Resiliency, Innovation, and Performance*, ed. M. J. Keegan and D. Chenok (Lanham, MD: Rowman & Littlefield Publishers, 2024), 123–34.
[8] OECD, *G20 Survey on Agile Approaches to the Regulatory Governance of Innovation* (OECD Directorate for Public Governance, 2021).

Unlike traditional academic or industry-led pilots, the proposed quantum sandbox encourages shared ownership of the learning process. This participatory approach not only builds institutional capacity but also strengthens democratic legitimacy, making the sandbox environment far more compelling than a conventional course on quantum technologies.

1. Using sandboxes for agenda setting

Quantum sandboxes serve not only as experimental environments but also as strategic spaces for surfacing unresolved regulatory and policy questions. To maximise their agenda-setting function, insights generated should be systematically captured, shared, and revisited to inform adaptive policymaking. Given the cross-sector nature of quantum technologies, disseminating findings to regulators, industry, academia, and civil society is essential.

2. Creating new learning experiences

In contrast to conventional pilots, quantum sandboxes promote shared ownership. Public sector actors are not passive observers but co-creators alongside technologists. In this way operational sandboxes serve as unique opportunities for policymakers to engage in experiential learning – learning by doing,[9] which has become a priority in G20 digital economy agendas in recent years.[10] They support near-term quantum applications with defined selection criteria, enabling public sector actors to observe and shape real-time use cases. This cumulative learning builds the foundation for more effective regulation.[11] This aligns with the idea that, more than experimenting per se, we are engaging in a

[9] OECD, *Regulatory Sandboxes in Artificial Intelligence*, *OECD Digital Economy Papers*, no. 356 (OECD Publishing, 2023).
[10] Santos, Bruna. 2024. "G20 Brazil Summit: A New Inflection Point for the Digital Agenda." *Global Solutions Initiative*, December 19, 2024. https://www.global-solutions-initiative.org/article/g20-brazil-summit-a-new-inflection-point-for-the-digital-agenda/ .
[11] Jay Obernolte, "Reps. Obernolte, Stevens Introduce New Bill to Accelerate Quantum Computing Applications in US," *Press Release*, April 20, 2023.

process of cumulative learning that will enhance the quality and effectiveness of future experimentation.[12]

3. Leveraging existing institutional capacities and experiences

Many jurisdictions already possess experience with sandboxes in fintech, health, AI, and data governance.[13] These learnings can be adapted to the quantum context. By drawing on proven legal and governance models, the quantum sandbox can scale more effectively while avoiding duplication and institutional inertia. Early and active public sector participation will be key to operational success.

4. Adopting a proactive rather than reactive approach to safeguards design

A sandbox enables public institutions to anticipate developments, experiment with forward-looking regulatory frameworks, and prepare for wider adoption.[14] This shift from a reactive to a proactive posture enhances the resilience, relevance, and adaptability of the regulatory system. This allows policymakers to cope better with the speed and uncertainty of quantum regulations and react to environment-specific learnings quickly.

5. Exploring practical use cases within governments for quantum computing

Quantum technologies can enhance public services by improving data processing, optimising logistics, boosting cybersecurity, and enabling more

[12] Urs Gasser and Viktor Mayer-Schönberger, "On the Shoulders of Others: The Importance of Regulatory Learning in the Age of AI," *Virginia Journal of Law and Technology* 28, no. 1 (2024): 1–14.
[13] International Bank for Reconstruction and Development, *Global Experiences from Regulatory Sandboxes*, Report No. 8 (The World Bank Group, 2020).
[14] OECD, *Regulatory Experimentation: Moving Ahead on the Agile Regulatory Governance Agenda*, *OECD Public Governance Policy Papers*, no. 47 (OECD Publishing, 2024).

efficient, transparent, and responsive government operations.[15] This puts governments in the situation of becoming both regulators and potential users of quantum technologies. They should leverage the sandbox to prototype and evaluate quantum applications relevant to their missions.[16] The identified available quantum solutions should then be fed back to the G20 working group on digital economy for further strategical advancements.

This becomes particularly pertinent in low- and middle-income countries, where innovative instruments are vital for fostering engagement with quantum technologies and their applications. Given that real-world experimentation in this domain demands a mature technical and regulatory infrastructure, quantum sandboxes offer a valuable means of lowering entry barriers. By providing structured environments for exploration and capacity building, they can catalyse existing interest and contribute to shaping coherent national strategies with long-term impact.

In light of this, it is recommended that the G20 digital agenda place stronger emphasis on capacity building for quantum computing. The development of a comprehensive roadmap for the implementation of quantum sandboxes across diverse national contexts is advised. This roadmap should draw on the experiences of governments that have already acted on individual recommendations, highlight the countries and institutions best positioned to benefit from these frameworks, and articulate clear methodologies for experimentation and evaluation.

This way, quantum sandboxes can serve as a scalable and adaptive model for promoting the responsible, inclusive, and regionally attuned development of quantum technologies within the G20.

[15] AWO Agency, "Quantum Computing and the Global South," *AWO*, accessed April 7, 2025, https://www.awo.agency/blog/quantum-computing-global-south/ .
[16] Ganga. Ibid.

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