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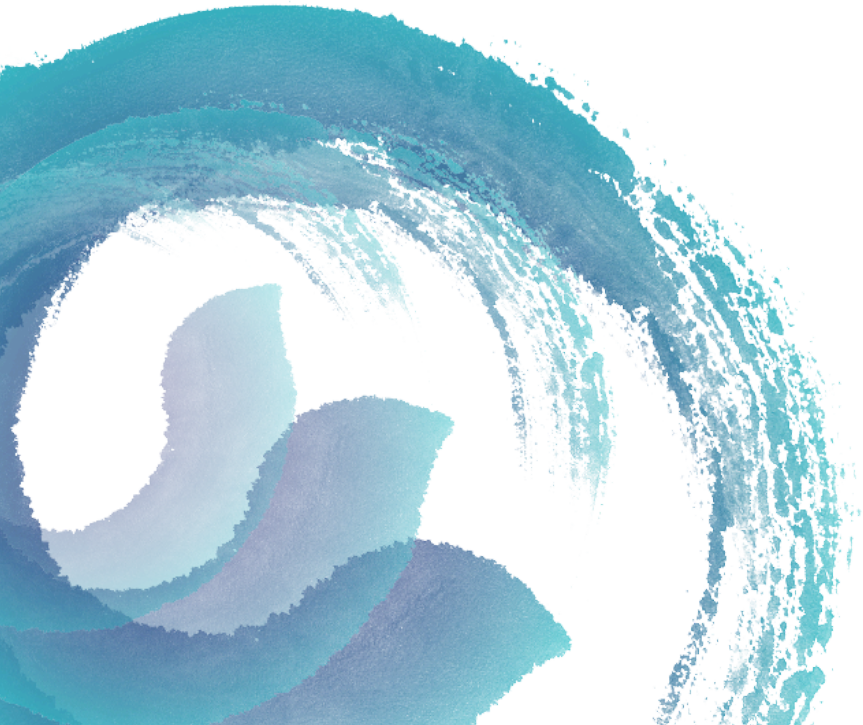

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ABSTRACT

This exploratory policy paper examines the role of emerging technologies - particularly quantum technologies (QT) - in shaping the future of cooperation between the European Union (EU) and Latin America and the Caribbean (LAC) (At this stage this document does not analyze the Metaverse). It situates technological innovation within the broader context of geopolitical uncertainty and underscores the need for governance frameworks that safeguard human agency, protect rights, and foster inclusive development. Drawing on regional understandings of "emergence," the paper highlights how LAC countries increasingly view these technologies as drivers of socio-economic transformation, while also recognizing persistent structural gaps in investment, education, and institutional capacity.

Quantum technologies are identified as a strategic priority, embodying both novelty and uncertainty while holding transformative potential. Although the region hosts recognized "islands of excellence" within leading universities, new initiatives are also emerging in countries traditionally less visible in global debates, reflecting LAC's aspiration to move beyond adoption toward generating knowledge and innovation. At the same time, systemic weaknesses - fragmented research, underfunded ecosystems, and the ongoing risk of brain drain - continue to limit regional leadership. Addressing these challenges requires educational reform guided by established frameworks such as the European Competence Framework for Quantum Technologies (CFQT), and the European Quantum Flagship. Coupled with equitable EU-LAC cooperation, these measures are essential to building human capital and resilient innovation systems.

Ultimately, the paper calls for structural investment, reciprocal exchange mechanisms, and stronger multilateral collaboration to enable LAC to transition from a technological adopter to a developer of contextually grounded innovations capable of contributing to global socio-technical challenges. At the same time, these bi-regional mechanisms aim to support the EU in advancing its own technological frontiers by fostering new human capital exchanges and ensuring continuous knowledge flows that both enhance the socio-technical dimensions of quantum computing and accelerate its regional development.

This exploratory paper is a product of HEMISPHERES, an international collaboration exploring technology, policy, and regulation across the EU and LAC. It represents the culmination of a joint effort by a Working Group of academics from both regions, reflecting the rich diversity of their experiences and opinions. While individual contributors express their views in a personal capacity and may not agree with every statement, they are united by a shared commitment to fostering mutual learning between these distinct regulatory landscapes

1. INTRODUCTION: A STRATEGIC MOMENT FOR EU-LAC COOPERATION

In examining the role of emerging technologies, in EU-LAC cooperation, this exploratory policy paper adopts a forward-looking perspective. Given the nascent state of these technologies - particularly quantum - descriptive analysis of the current landscape offers only a partial picture. What matters most at this stage is anticipating future trajectories, identifying structural gaps, and outlining strategies that can guide policy and cooperation in the years ahead.

In the current climate of growing geopolitical uncertainty, EU and LAC countries stand at a pivotal juncture. If strategies are aligned and developed in a structured and forward-looking manner, the opportunities for mutual benefit are immense. Within this context, emerging technologies occupy a central role in shaping the future of interregional cooperation. They carry extraordinary transformative potential but also demand careful governance to ensure that innovation advances in ways that protect rights, safeguard human agency, and foster inclusive societal progress.

Emerging technologies - including synthetic biology, neurotechnology, artificial intelligence (such Agentic IA), immersive systems, and quantum technologies (such as Quantum Machine Learning) - are characterized by radical novelty, rapid development, and high levels of uncertainty regarding their trajectories and impacts. For policymakers, the challenge lies in enabling innovation that drives social and economic benefits, while simultaneously anticipating risks and establishing frameworks that align technological progress with broader societal values (OECD, 2024).

Academic and policy debates reflect this complexity. While definitions of “emerging technologies” vary, there is broad agreement around five attributes: radical novelty, fast growth, coherence, significant socio-economic impact, and uncertainty or ambiguity (this refers to the contested ways these technologies are defined and interpreted) (Rotolo et al., 2015). Yet, perspectives differ depending on the lens applied: some emphasize socio-economic transformation, others stress uncertainty or growth dynamics. Adding to this panorama, technologies are

often grouped under broad labels (e.g., nanotechnology, synthetic biology) despite their diverse socio-technical characteristics, applications, and governance challenges.

In LAC countries, policy frameworks highlight an important contextual insight: a technology is considered “emerging” not only when it is novel, but when it is not yet widely adopted in a given setting while holding the potential to radically transform business, industry, or society (MinTIC, 2020). This perspective underscores that emergence is not absolute but relative to place, domain, or application; the approach the LAC region has taken toward emerging technologies is best understood as framing them primarily as agents of socio-economic transformation (Tenjo-Patiño, A., Bello, D., & Montoya, F., 2025).

Such framing is particularly relevant in LAC where adoption pathways often diverge from those in Europe or North America due to distinct socio-economic conditions and policy environments. Another critical vector shaping these dynamics is the region’s level of technological readiness. The challenge is not merely that emerging technologies are insufficiently diffused, but that many LAC countries still face structural lags in foundational infrastructures. For instance, it is difficult to meaningfully invest in quantum networks when 5G connectivity is not yet widely deployed. This technological sequencing problem constrains the ability to translate global advances into local impact, reinforcing the need for policy strategies and technical development that balance forward-looking innovation with the urgent imperative of closing existing digital gaps.

This definitional fluidity and the diverse approaches to measuring “emergence” underscore a central tension: while emerging technologies offer extraordinary opportunities for innovation, competitiveness, and cooperation, the lack of shared conceptual and regulatory frameworks - as well as persistent gaps in infrastructure - undermines effective resource allocation, policy design, and international collaboration. It is precisely in this space, between uncertainty and opportunity, that Europe and LAC countries can find common ground to co-develop strategies that both mitigate risks and unlock the transformative potential of technological innovation. For this to materialize, LAC must move beyond the role of passive adopter and position itself as an active co-creator of global technological trajectories - both in application development and

governance - since this is not only desirable but a strategic imperative for long-term economic development, societal resilience, and regional sovereignty.

The importance of contextual analysis becomes evident when examining current trends in technology adoption across LAC. A December 2023 survey by Harvard Business Review Analytic Services, covering 372 private sector organizations across Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Peru, illustrates the state of emerging technology uptake in the region (Harvard Business School, 2023). The findings show:

- Generative AI (53%) and other AI applications (44%) are the most prevalent.
- Biometrics (37%), 5G (32%), and immersive technologies (28%) follow.
- More advanced fields, such as quantum computing (5%), remain marginal.

These results provide a valuable snapshot of where attention and investment are currently concentrated in LAC, highlighting not only the technologies already in use but also those where policy, governance, and capacity-building efforts could foster stronger convergence with EU counterparts. It is also relevant to emphasize that although quantum computing adoption remains marginal in the region (5 %), small-scale initiatives are beginning to emerge in Latin America and the Caribbean (Venegas-Gómez, 2023). These developments, though modest, indicate that the region's trajectory is diverse and not limited to its largest economies. For example, in 2023 Brazil's SENAI CIMATEC was designated as a national Competence Center in Quantum Technologies under the Embrapii-MCTI initiative, backed by an investment of R\$ 60 million - approximately €10.8 million at current (2025) exchange rates - which reinforces the country's growing commitment to building specialized infrastructure and human capital for quantum innovation (Embrapii & MCTI, 2023). Understanding these regional dynamics - social, economic, and institutional - is essential for identifying areas of synergy and building sustainable cooperation between EU and LAC in the emerging-technology landscape.

Within the framework of the HEMISPHERES Consortium, six thematic Working Groups have been established: Artificial Intelligence; Emerging Technologies & Metaverse; Internet; Platforms, Equity & Safety; Privacy & Security; and Youth & Media. As artificial intelligence is already comprehensively addressed through its own dedicated group, the question arises as to which emerging technology this Working Group should prioritize. Building on international foresight exercises and global policy debates, the group has chosen to focus on quantum technologies.

This reflects its recognition as a technology that embodies the defining attributes of emergence: radical novelty, rapid growth, coherence, significant socio-economic impact, and inherent uncertainty and ambiguity.

At this juncture, it is crucial that LAC positions itself not merely as a technological adopter but as a region capable of contributing to the creation, scaling, and delivery of advanced technological solutions. This ambition must follow a dual approach: first, by building the technical capacity to develop and adapt applications that address local and regional priorities; and second, by engaging in the governance and standard-setting processes that will determine how these technologies evolve globally. Without progress on both fronts, LAC risks remaining dependent on external providers and excluded from shaping the norms that will govern technological deployment. Establishing bridges for cooperation - both within the region and with international partners - will therefore be essential to ensure that LAC countries are active contributors to the pathways guiding the development of transformative technologies such as quantum computing.

The urgency of this endeavor is underscored by the potential impact of quantum technologies on sectors central to the region's development, including health, energy, and agriculture. In contexts marked by persistent inequality, these technologies are not only strategic but also urgent: they could support breakthroughs in medical research and drug discovery, contributing to SDG 3 (Good Health and Well-Being); optimize energy grids to facilitate the integration of renewable sources, advancing SDG 7 (Affordable and Clean Energy); and enhance agricultural productivity through advanced crop prediction models, directly addressing SDG 2 (Zero Hunger). Framing quantum development in relation to these sectors highlights that LAC's participation is not an abstract ambition but a concrete necessity for building more resilient, equitable, and sustainable societies.

2. LAC´S PUBLIC POLICIES ON QUANTUM TECHNOLOGIES

Over the past five years, several LAC countries have taken initial steps toward positioning quantum technologies within their national science, technology, and innovation (STI) agendas. These efforts reflect a growing recognition that quantum computing, communication, and sensing will play a decisive role in shaping competitiveness and sovereignty in the coming decades. Yet, while strategies and roadmaps are beginning to emerge, most remain at the level of policy design and proposal. Concrete implementation mechanisms - such as long-term funding instruments, dedicated institutions, or coordinated industrial pilots - are still largely absent, leaving the region at risk of lagging behind more mature global ecosystems.

Argentina has been among the first movers. Through the Programa Interinstitucional de Fortalecimiento de la Ciencia y la Tecnología Cuánticas launched in 2022, the Ministry of Science explicitly identified quantum science as a strategic priority within the Plan de Innovación 2030. In 2023, it financed seven R&D projects and invested approximately US$1.7 million to modernize and establish laboratories led by returning researchers (Ministerio de Ciencia, Tecnología e Innovación, 2023). While this marks a significant policy commitment, officials have underscored that Argentina's development in the field remains at an early stage, with the goal of preventing talent flight by gradually building local capacity.

Chile has advanced rapidly on the policy front, convening in 2024 a high-level Quantum Technologies Advisory Commission that produced a comprehensive roadmap covering governance, education, R&D, and private-sector engagement. Its recommendations include establishing a permanent National Quantum Commission, creating competitive research funds, and launching programs to attract and retain talent (Ministerio de Ciencia, Tecnología, Conocimiento e Innovación, 2024). The plan builds on decades of public investment in fundamental research, providing Chile with a relatively strong foundation to position itself as a regional hub. Yet, despite the clarity of the roadmap, its

implementation remains dependent on political will and sustained budgetary allocations.

Colombia has incorporated quantum into broader intelligent technologies initiatives led by its Ministry of Science (MinCiencias). Calls such as Colombia Inteligente: Ciencia y Tecnologías Cuánticas e Inteligencia Artificial para los Territorios seek to link companies, communities in the agricultural sector, and universities to concrete social and economic challenges, while national forums and international dialogues signal an ambition to play a coordinating role in regional policy. Nevertheless, these programs remain exploratory, with limited continuity and without a dedicated national strategy or long-term funding framework.

Other countries are at earlier stages. Uruguay has identified quantum computing and cybersecurity as emerging priorities in its long-term development vision (Uruguay 2050), but has yet to allocate significant resources to the field. Smaller Caribbean states have only begun to discuss quantum in public debates, often framing it as a distant opportunity or risk rather than an immediate policy priority.

Taken together, these developments suggest that LAC countries have begun to build their governance infrastructure, nonetheless still lag behind EU countries. Governments are experimenting with roadmaps, creating advisory commissions, and signaling intent through national and international fora. However, the region's engagement remains overwhelmingly propositional rather than operational. Funding volumes are still modest, institutional frameworks remain under construction, and most initiatives lack mechanisms for sustained execution. Without moving from strategic vision to practical implementation, there is a real risk that LAC's quantum policies will remain aspirational documents rather than engines of scientific, industrial, and societal transformation.

In this context, establishing bridges for cooperation - both within the region and with international partners - becomes essential. Such cooperation must follow a dual track: strengthening technical capacity so that quantum solutions can be adapted in sectors such as health, environment, and agricultural needs, while also advancing governance participation to ensure that global standards and regulatory frameworks incorporate LAC perspectives. The rationale is clear: without technical capabilities, the region risks dependency on external providers; without governance influence, it forfeits the ability to shape how technologies will

impact equity, sovereignty, and inclusive development. Leveraging platforms such as the EU-LAC Digital Alliance and regional initiatives like CLEI (Centro Latinoamericano de Estudios en Informática) provides a pathway to accelerate cooperation and to anchor innovation in shared priorities that link competitiveness with social justice (Greinert, 2023).

3. LAC´S REGIONAL GAPS AND CHALLENGES

Despite growing momentum around emerging technologies, LAC countries continue to grapple with structural gaps that hinder their capacity to fully harness their transformative potential. A central challenge is the region's persistently low investment in innovation: research and development (R&D) spending averages only 0.62% of GDP - around four times less than the global average - a deficit that explains much of the productivity gap with economies such as Japan, Spain, or Sweden (World Bank, 2023; World Bank, 2025). Education systems also remain a bottleneck. Although the region registered notable improvements in OECD's Programme for International Student Assessment (PISA) between 2003 and 2012, tertiary education continues to underperform in building innovation capacity, with only 12% of higher education students enrolled in science and engineering - placing Brazil 96th out of 102 countries in global rankings (International Trade Centre, 2023). Moreover, financial support for science and technology remains fragmented and short-term, while research initiatives often rely on isolated individual efforts rather than consolidated institutional strategies. These constraints slow the development of robust research environments and prevent the emergence of sustainable pathways from experimentation to application.

Quantum technologies illustrate this duality well. On the one hand, awareness is gradually increasing through conferences, training programs, and regional networks that introduce students and researchers to the field. On the other hand, higher education and research institutions often lack the critical mass of programs, laboratories, and faculty needed to provide specialized training at scale. While some universities have launched courses and master's programs with quantum-related content, such initiatives remain scattered and insufficiently specialized, limiting access and regional impact. Moreover, the absence of sustained public investment exacerbates the challenge: without long-term funding, neither universities nor companies are able to create the rigorous infrastructures necessary for advanced research and applied innovation. As a result, students and young researchers face few opportunities to bridge theoretical learning with practical experience, perpetuating the risk of brain drain and reinforcing dependency on external ecosystems (Tenjo-Patiño, Bello, & Montoya, 2025).

The IEEE study (2024) offers a detailed view of this uneven landscape. Of the 1,245 quantum-related papers surveyed in LAC, 1,099 were authored by universities listed in the QS Latin America & Caribbean rankings, while 146 came from institutions outside QS. Brazil, Mexico, and Argentina dominate regional output, though cross-country collaboration remains modest, with only 80 co-authored papers involving LAC partners - typically no more than three countries at a time.

At the institutional level, disparities are even more pronounced. Of the 430 QS-ranked universities, only 190 (≈44%) have published at least one paper in quantum computing. Nearly half of these institutions (98) have published fewer than four papers, and only 48 have produced more than 10. Just five universities stand out as regional leaders with over 50 publications each:

- Universidade de São Paulo (Brazil) - 85 papers
- Universidad de Buenos Aires (Argentina) - 78 papers
- Universidad Nacional Autónoma de México (México) - 58 papers
- Universidade Federal do Rio Grande (Brazil) - 57 papers
- Universidade Estadual de Campinas (Brazil) - 51 papers

In proportional terms, only Uruguay (75%), Chile (70%), and Brazil (65%) have more than half of their QS-ranked universities publishing in this field. In most other countries, fewer than half of universities are engaged, underscoring the fragmented and uneven character of quantum research in the region.

Globally, LAC remains peripheral. The 2023 Global Quantum Computing Map shows the United States, China, and Europe leading development, with Japan, South Korea, Singapore, and Australia also emerging as major participants. In contrast, no LAC country features prominently in public funding initiatives or in the global distribution of quantum companies (Venegas-Gómez, 2023). The absence of large-scale national programs explains why the region is often missing from global funding and industry landscapes, leaving researchers without the systemic support available elsewhere.

This structural gap also highlights important pathways for bi-regional cooperation between LAC countries and the EU. Stronger institutions, professional exchanges, and active collaboration in laboratories - as well as opportunities for joint experimentation in advanced research - represent significant avenues to

strengthen capabilities on both sides and unlock the potential of quantum technologies through closer EU-LAC partnerships.

Taken together, these findings illustrate both progress and persistent limitations. LAC countries host islands of excellence concentrated in a handful of universities, yet the broader ecosystem is hindered by insufficient specialization, incipient policy frameworks, and chronic underinvestment. Addressing these challenges will require targeted national strategies, sustained government funding, and mechanisms for brain circulation to avoid permanent loss of talent (Venegas-Gómez, 2020). To close this gap, the region will need to advance targeted educational reforms, sustained government funding, and deeper international cooperation. Another critical factor - addressed in more detail later - is the role of private and industrial investment. Without stronger participation from the private sector in financing research, developing applications, and creating employment pathways, even the most ambitious public strategies will struggle to achieve impact. Only by addressing these structural challenges can the LAC region strengthen its human capital, foster innovation, and position itself as a relevant and active actor in the global quantum technology race.

4. ALIGNMENT OF EDUCATIONAL MODELS FOR BI-REGIONAL COLLABORATION

Closing the region's quantum education gaps will require not only increased investment but also deliberate alignment with international standards, such as those advanced under the European Quantum Flagship - which will be discussed in greater detail in the following sections. Education is the cornerstone of sustainable innovation ecosystems, and without coherent frameworks to structure competencies, LAC risks remaining a peripheral adopter rather than an active developer of quantum technologies. Bi-regional collaboration provides a strategic opportunity in this regard: shared models can accelerate capacity-building while ensuring that training pathways respond to both global benchmarks and local realities.

The European Competence Framework for Quantum Technologies (CFQT) offers a concrete entry point by providing a structured and standardized model for defining skills, competencies, and qualifications in the quantum field (European Commission, 2024). By adapting and contextualizing this framework to local socio-economic and cultural realities, universities in LAC could align curricula with these international frameworks while making them more accessible to regional students. Introductory courses and specialized tracks - developed with bilingual resources, flexible elective formats, context-sensitive content, and interdisciplinary pathways - would not only broaden participation beyond STEM students but also enable future professionals in fields such as finance, health, and climate to engage with quantum applications (Tenjo-Patiño, Bello, & Montoya, 2025).

Implementing educational structures inspired by the CFQT could also serve as a gateway to deeper bi-regional cooperation between the EU and LAC. Joint training programs, academic mobility schemes, and collaborative research initiatives would allow students and professionals from both regions to benefit from exposure to diverse educational models and industry ecosystems. Such exchanges would expand the talent pool, accelerate knowledge transfer, and reinforce interregional trust. Importantly, they would also strengthen the

foundations of bilateral cooperation by fostering networks of future professionals whose careers will unfold across both regions (Greinert et al., 2023).

At the same time, it is essential to acknowledge and address the risks that accompany mobility and exchange programs. Historically, cooperation between developed and developing regions has often produced asymmetric benefits, with highly trained students and professionals remaining abroad - exacerbating brain drain and weakening local ecosystems. To prevent this dynamic, EU-LAC cooperation in quantum technologies must be firmly grounded in principles of equality, reciprocity, and mutual benefit. This requires embedding safeguards such as structured return pathways, co-funded fellowships, and strong links to local research and industry opportunities. By ensuring that trained professionals reintegrate into their home ecosystems while maintaining active collaboration with EU partners, exchanges can become mutually reinforcing rather than extractive, strengthening both EU and LAC capacities simultaneously (Venegas-Gómez, 2020).

If pursued strategically, the implementation of CFQT-inspired educational structures can create the conditions for LAC to become not only a technological adopter but also a generator of advanced knowledge, skills, and innovation. By embedding cultural adaptation, reciprocity, and equal partnership into program design, LAC and Europe can transform educational cooperation into a driver of long-term competitiveness, deeper integration, and stronger global positioning in the field of quantum technologies. Such a strategy would not only close regional gaps but also help ensure that the next generation of quantum professionals emerges from both sides of the Atlantic equipped to innovate, collaborate, and build a truly shared technological future (Tenjo-Patiño et al., 2025; European Commission, 2024).

In considering the trajectories of emerging technologies, it becomes clear that LAC faces both opportunities and persistent structural constraints. The Strategic Research and Industry Agenda (SRIA 2030) for quantum technologies in Europe identifies education and workforce development as a fundamental pillar for ensuring competitiveness and technological sovereignty (European Quantum Flagship, 2024). This orientation is particularly relevant for LAC, where fragmented educational offerings, limited investment, and uneven institutional capacities continue to hinder the translation of technological awareness into sustainable

innovation ecosystems. Adapting the SRIA 2030's education and workforce development pillar to regional realities could provide LAC with a practical policy blueprint for advancing bi-regional cooperation. By prioritizing structural investment in education and research ecosystems and embedding reciprocal exchange mechanisms, the region can move from being a late adopter of emerging technologies to an active co-creator of global solutions. Such an approach would not only address capability gaps but also lay the foundations for a more balanced, long-term partnership between LAC and Europe in the governance and development of transformative technologies.

For LAC, the strategic priority is not simply to replicate EU models, but to adapt and contextualize them with local relevance and institutional strength. Programs such as the European Competence Framework for Quantum Technologies demonstrate the value of structured competence frameworks that align skills, curricula, and research with industrial and societal needs. A LAC adaptation - sensitive to socio-economic realities, linguistic diversity, and institutional differences - could provide the foundation for developing regional education pathways that are internationally compatible while locally relevant. Embedding quantum and emerging technologies into broader STEM education, while also opening interdisciplinary tracks in fields such as law, health, and climate sciences, would help prepare a workforce capable of addressing the unique challenges of the region.

A concrete example of this alignment in action is the recent strategic alliance between Cemex, IBM, and Tecnológico de Monterrey (Monterrey Tech) to explore quantum computing applications in Mexico (BNAmericas, 2024). This collaboration illustrates how local institutions can leverage international expertise to develop quantum solutions attuned to regional industrial priorities, such as supply chain optimization, sustainability in resource-intensive industries, and advanced materials modeling - areas where Cemex's operational context offers rich, real-world laboratories. By co-developing these applications, the partnership not only enhances industrial relevance but also provides tangible opportunities for students and researchers to participate in cutting-edge innovation embedded in familiar socio-economic environments.

Complementing these industry-driven efforts, the Quantum Hackathon LATAM 2025: Quantum for Climate, co-organized by the University of Montevideo and the

Open Quantum Institute, serves as a powerful example of academic-multilateral engagement and capacity-building in action. Scheduled to take place in Montevideo in October 2025, this event brings together students, academics, and practitioners to address climate-related challenges through quantum computing tools and collaborative ideation (Quantum Hackathon LATAM, 2025). By focusing on regionally pressing issues like environmental resilience and sustainability, the hackathon reinforces the value of contextualized, application-oriented quantum education and encourages active participation in co-creating solutions rather than passively consuming frameworks.

In this way, such collaborations exemplify a dual-purpose strategy: they ground education and competency-building in actual industry needs, while also enabling LAC institutions to co-create quantum trajectories that reflect their own strategic priorities. This approach bridges the gap between global frameworks and local application, ensuring that emerging technologies become instruments of regional strength and innovation - rather than external impositions.

To achieve this, cooperation with regional institutions such as the Centro Latinoamericano de Estudios en Informática (CLEI), alongside multilateral entities like UNESCO and initiatives under the EU-LAC Digital Alliance, will be essential. These actors can help establish structural strategies that facilitate the adaptation of global standards to local contexts and promote cross-regional recognition of skills and qualifications. Importantly, education policy must be framed not only as human capital development, but also as a mechanism for enabling bilateral professional and academic exchanges with Europe. Such exchanges can accelerate knowledge transfer, foster joint innovation, and generate trust among future professionals, provided they are implemented in a way that guarantees reciprocity and shared benefit.

5. BI-REGIONAL FUNDING: A STRATEGIC LEVER FOR EU-LAC QUANTUM COLLABORATION

Bi-regional funding mechanisms offer a critical pathway to transform shared ambition into tangible outcomes in quantum technologies. By leveraging resources from both EU programs and LAC agencies, these funding structures enable joint ownership of research, reinforce capacity-building, and foster co-created innovation ecosystems that reflect local needs and global standards.

Historically, this model proved effective under Horizon 2020 (H2020), where EU institutions were required to partner with counterparts in LAC countries, leading to the creation of robust multilateral research consortia and amplifying impact across the region. A case in point is the HEMISPHERES project, an Erasmus+ initiative that, while not funded under H2020, aligns with the same principle of fostering bi-regional collaboration. It demonstrates how such frameworks not only democratize access to research funding but also embed research capacity within LAC universities and laboratories.

More recently, the EU-LAC Digital Accelerator has shown the potential of corporate-led, bi-regional innovation initiatives by issuing open calls that stimulate joint corporate participation from both regions (European External Action Service [EEAS], 2025). Adapting this model to support quantum technologies could open new pathways for applied research, industry-academia collaboration, and scalable technological deployment.

Importantly, all of this is anchored within the broader framework of the evolving EU-CELAC Common Research Area (CRA). Guided by the Joint Initiative for Research and Innovation (JIRI), the CRA seeks to deepen cooperation across four pillars: researcher mobility, research infrastructures, addressing global challenges, and innovation (European Commission, 2024). The CRA establishes both a political and institutional foundation for deploying bi-regional funding in a manner that is coordinated, strategic, and mission-oriented.

To maximize impact in quantum technologies, a dedicated EU-LAC Quantum Research Fund should be considered, structured around joint calls, multi-year

stability, infrastructure support, and alignment with both EU and LAC strategic roadmaps. Through such mechanisms, bi-regional cooperation becomes a way for LAC to build its own innovation capabilities in quantum technologies, while the EU gains stronger, equitable partners in a region with growing potential.

6. INDUSTRIAL PARTNERSHIPS, INVESTMENT, AND CROSS-REGIONAL ALIGNMENT

Aligned with the vision for a future EU-LAC Quantum Research Fund, additional initiatives are necessary to ensure that educational models do not remain disconnected from the realities of the labor market. One of the region's enduring challenges is the lack of job security for graduates in cutting-edge fields, which reflects a broader pattern in LAC's technology sector where education is often oriented toward immediate industrial needs rather than long-term innovation strategies. Industrial collaboration, particularly when embedded in bi-regional partnerships, can serve as a powerful corrective by linking academic training to sustainable career pathways.

A concrete illustration of this approach is the partnership established in 2024 between Germany's Kipu Quantum and Uruguay's Quantum-South. This strategic alliance is focused on developing quantum computing applications for industries such as telecommunications, banking, financial services, and logistics, combining Kipu's hardware-specific quantum algorithms with Quantum-South's regional expertise (Quantum Zeitgeist, 2024). By centering the collaboration on practical industrial challenges, the initiative creates direct avenues for students and researchers to transition from training into employment, while simultaneously embedding EU technological expertise into LAC innovation ecosystems.

Such cases highlight how cross-regional industrial alignment can complement educational reform and research funding. They reinforce the idea that industrial partnerships are not peripheral but central to sustaining innovation, as they generate demand for specialized skills, anchor research infrastructures locally, and ensure that knowledge transfer has tangible economic and social impacts. Extending this model through structured industrial exchanges - parallel to academic mobility programs - would allow LAC firms to replicate and adapt successful EU industrial practices while simultaneously creating new spaces for collaboration and commercialization. For EU partners, these initiatives also carry significant advantages: they provide access to new markets and application domains, create opportunities to test and scale quantum solutions in diverse socio-economic contexts, and strengthen supply chains by integrating a wider

pool of talent and research capabilities. In this sense, industrial alignment fosters reciprocity, ensuring that both regions benefit from innovation spillovers and that the EU-LAC partnership evolves into a genuinely co-created quantum ecosystem.

7. MOBILITY NETWORKS BETWEEN EU-LAC AND WITHIN LAC

Expanding mobility networks - modeled on initiatives like Erasmus Mundus - can significantly amplify the research impact of LACC universities by fostering highly skilled talent, strengthening institutional ties, and creating durable scientific collaborations. The QuanTEEM (Quantum Technologies and Engineering) master's program illustrates how structured, high-quality mobility can become a platform for bi-regional cooperation rather than one-directional capacity-building.

QuanTEEM is a two-year Erasmus Mundus joint degree coordinated by a consortium of EU universities - Université Bourgogne Franche-Comté (France), Technische Universität Kaiserslautern (Germany), and Aarhus Universitet (Denmark) - covering the full spectrum of quantum technologies, including computation, communication, sensing, simulation, and engineering applications (QuanTEEM, 2024). Students complete international mobility periods across partner institutions, gaining interdisciplinary training, access to advanced laboratories, and exposure to industrial collaborations.

For LAC, participation in such programs is not only an opportunity to access advanced research environments and training pathways that remain scarce across the region, but also a way to channel this knowledge into addressing urgent development priorities. Returning graduates can help elevate local institutions and seed new collaborations, but their skills also become instrumental in applying quantum technologies to challenges aligned with the Sustainable Development Goals (SDGs). Quantum simulation can contribute to climate modeling that enhances resilience in a region disproportionately affected by extreme weather events (SDG 13: Climate Action); quantum optimization can strengthen energy distribution grids, helping countries integrate renewables more efficiently into fragile infrastructures (SDG 7: Affordable and Clean Energy); and quantum-enhanced data analysis can improve crop prediction and sustainable agriculture, sectors central to food security and export competitiveness (SDG 2: Zero Hunger).

These applications illustrate that mobility is not solely a matter of academic exchange, but a mechanism through which talent and innovation can be directed toward solving pressing societal challenges. It is precisely this ability to connect education with impact that makes mobility attractive not only for LAC, but also for Europe. By working with LAC students and researchers, EU universities and industries gain access to socio-economic contexts where the practical deployment of quantum applications can be tested at scale. Domains such as agriculture, logistics, and energy in LAC serve as real-world laboratories for refining EU technologies, while also expanding talent pipelines and opening pathways to rapidly growing emerging markets.

In this sense, mobility generates a genuinely two-way flow of knowledge, innovation, and opportunity. LAC leverages EU expertise to strengthen its innovation ecosystems and address critical development needs, while Europe benefits from expanded application domains, diversified perspectives, and deeper ties with a strategically important region. Embedding mobility within EU-LAC cooperation therefore, transforms education into a shared investment with global relevance. When designed with reciprocity, structured return pathways, and mutual innovation goals, programs like QuanTEEM can ensure that both regions cultivate quantum professionals not only capable of innovating and collaborating, but also of applying their expertise to societal challenges that resonate far beyond their own borders.

8. OPEN QUESTIONS AND CONSIDERATIONS

As with any field defined by rapid innovation and high uncertainty, it is important to underline that there is no one-size-fits-all model for governing emerging technologies. Quantum technologies, like other transformative fields, evolve within socio-economic, political, and cultural environments that differ not only between EU and LAC but also within each region. Policy frameworks must therefore remain flexible, adaptive, and responsive to changing realities, rather than seeking premature closure through rigid prescriptions.

The volatility of the geopolitical landscape further amplifies this challenge. Sudden shifts in international alliances, trade dynamics, or technological breakthroughs can quickly alter the parameters within which cooperation is negotiated. For LAC, this means that strategies must anticipate disruption while retaining the capacity to pivot - avoiding dependence on any single governance model or technological trajectory. For Europe, it underscores the importance of cultivating resilient partnerships that can withstand external shocks and continue to deliver mutual benefit.

This context invites several open considerations that policymakers on both sides should bear in mind. How can cooperation frameworks balance the need for technical capacity-building with an equally urgent need to participate in global governance and standards-setting? What mechanisms will ensure that exchanges do not exacerbate brain drain but instead foster circulation of talent and long-term ecosystem growth? To what extent should cooperation prioritize strategic sectors - such as health, energy, and agriculture - where quantum applications can directly advance the SDGs, versus investing in cross-cutting infrastructures with more diffuse impacts? And how can the EU-LAC partnership create institutional arrangements that remain credible and durable even as the wider geopolitical environment grows more fragmented?

Rather than offering fixed answers, these questions highlight the importance of flexibility, reciprocity, and contextual sensitivity. By keeping space open for adaptation and iteration, the EU-LAC partnership can avoid replicating outdated models and instead co-evolve strategies that remain relevant as technologies mature, societies change, and global dynamics shift.

9. POLICY RECOMMENDATIONS

Building on the analysis of opportunities, challenges, and cooperation models, this section outlines a set of policy recommendations designed to strengthen EU-LAC collaboration in the governance and development of quantum technologies. These recommendations emphasize the dual imperative of technical capacity-building and governance participation, ensuring that LAC is not only a beneficiary of technological advances but also a co-shaper of the rules, standards, and applications that will define their global trajectory. For the EU, such cooperation expands access to diverse application contexts - ranging from agriculture and energy to health - where quantum technologies can be tested and scaled in real-world conditions. It also strengthens talent pipelines, diversifies research networks, and consolidates Europe's role as a trusted partner in shaping inclusive, global innovation ecosystems.

The proposals are organized around key axes - education and talent development, research and funding mechanisms, industrial collaboration, multilateral governance, and societal impact - reflecting the systemic approach required to close existing gaps while creating conditions for sustainable innovation. Together, they provide a roadmap for moving from fragmented initiatives to coherent, bi-regional strategies that combine EU frameworks and resources with LAC contexts and priorities.

1. **Co-Develop National and Regional Quantum Strategies**

   EU and LAC governments should collaborate in designing mutually aligned quantum strategies, ensuring LAC moves beyond proposals toward implementation. The EU can share lessons from the Quantum Flagship, while LAC countries can integrate regional priorities. This avoids asymmetry and ensures strategies are jointly built rather than externally imposed.

2. **Establish an EU-LAC Quantum Research Fund**

   Both EU programs (e.g., Horizon Europe, Digital Europe) and LAC agencies should co-finance a dedicated EU-LAC Quantum Research Fund. Joint calls would require consortia with EU and LAC partners, ensuring co-ownership of

research outputs and equitable access to infrastructures. This builds on successful precedents like Horizon 2020's EU-LAC collaboration.

3. **Adapt and Co-Design Competence Frameworks**

   The European Competence Framework for Quantum Technologies (CFQT) should be adapted in co-creation with LAC universities, ensuring sensitivity to linguistic diversity, socio-economic realities, and local labor markets.

4. **Expand Bi-Regional Education and Interdisciplinary Tracks**

   Educational cooperation should embed quantum within broader STEM fields and create interdisciplinary EU-LAC programs in areas like law, health, climate, and agriculture. Joint curricula and bilingual resources would help democratize access while ensuring talent can address both EU and LAC societal needs.

5. **Strengthen Bi-Regional Industrial Partnerships**

   Cases such as Cemex-IBM-Monterrey Tech (Mexico) and Kipu Quantum-Quantum South (Germany/Uruguay) illustrate how EU-LAC industry-academia collaboration can produce regionally relevant applications. Policymakers should incentivize more joint EU-LAC industrial pilots, exchanges, and clusters to create employment pathways and stimulate commercialization across both regions.

6. **Expand Mobility Networks Between EU-LAC and Within LAC**

   Bi-regional mobility programs - modeled on Erasmus Mundus (e.g., QuanTEEM) - should be expanded to include LAC universities systematically. At the same time, EU support should strengthen intra-LAC mobility, so smaller or less-resourced institutions can benefit. Reciprocity must be ensured through return pathways and reintegration funding, preventing brain drain.

7. **Promote Brain Circulation as a Shared Goal**

   Mobility must be structured to benefit both regions. EU-LAC cooperation should establish co-funded fellowships, joint research positions, and bilateral industry placements that guarantee brain circulation. This ensures LAC talent reinforces local ecosystems while Europe benefits from a diversified talent pool.

8. **Build Regional and Bi-Regional Coordination Mechanisms**

   Strengthening regional coordination in LAC (e.g., through CLEI) while linking it to the EU-LAC Digital Alliance would create coherent structures for long-term cooperation. Such platforms should harmonize research agendas, share infrastructures, and prevent duplication, ensuring that EU-LAC projects build cumulative impact.

9. **Co-Invest in Research Infrastructures**

   EU-LAC cooperation should go beyond mobility and funding calls by jointly investing in shared infrastructures (e.g., quantum labs, simulators, cloud access). Shared facilities would anchor long-term cooperation, allow for distributed experimentation, and reduce structural gaps in LAC while giving EU researchers access to new application environments.

10. **Create Incentives for Private Sector Participation**

    EU and LAC should co-design innovation challenge funds, tax incentives, and co-financed R&D programs that actively involve companies on both sides. Private sector participation ensures that joint research translates into jobs, commercialization, and sustainable market opportunities.

11. **Anchor Cooperation in the SDGs**

    EU-LAC quantum cooperation should be explicitly linked to shared global challenges under the SDGs. Quantum applications in health (SDG 3), clean energy (SDG 7), and food security/agriculture (SDG 2) are of strategic importance for LAC, while providing Europe with large-scale testing grounds and new markets. Anchoring cooperation in SDGs ensures reciprocity, social legitimacy, and developmental impact.

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