KQUANTA RESEARCH

Unleashing the potential of Quantum Technology & AI in Financial Services

Shaping tomorrow, today

Executive Summary

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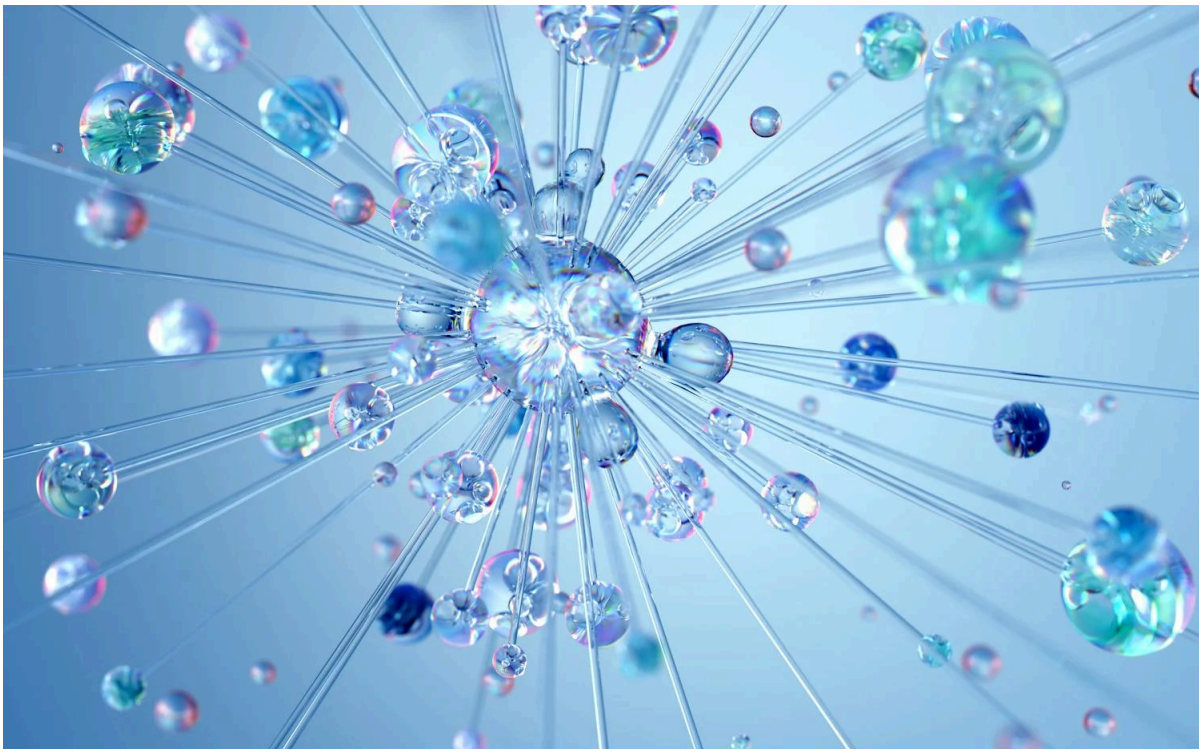
Purpose

- Demystify quantum technologies for financial professionals
- Examine the impact of convergence of AI and quantum technologies
- Facilitate informed dialogue among financial professionals, tech innovators, academia, regulators, and industry leaders

Objectives

- Establishing a Foundational Framework: Create a framework for Kquanta Research's Quantum Tech in FInance (QTIF) Insight series-comprising of roundtable discussions and expert-led sessions that will facilitate knowledge sharing, innovation, and collaboration, identify steps for responsible development and adoption.



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The financial services industry is on the brink of a quantum revolution, poised to transform operations, enhance capabilities, and redefine security. The question is no longer **"if"** quantum tech will impact the financial services, but "**when"** and **"how"** it will influence computational strategies.

As the UN marks the International Year of Quantum Science and Technology, this report explores the transformative impact of quantum and AI on the financial sector, with a focus on emerging markets and India, highlighting both the opportunities and challenges that lie ahead.

Key Findings

- Quantum Computing Potential: Projected investment in financial services to grow from US$80 million (2022) to US$19 billion (2032)
- Quantum & AI: Enhanced data processing and accelerated machine learning
- Transformative Applications: Derivative pricing, portfolio optimisation, risk analysis, and anomaly detection
- Cybersecurity Risk: Urgent need for Post-Quantum Cryptography (PQC)
- Talent & Regulation: Industry faces skills shortage and requires adaptive regulatory frameworks

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Convergence of AI & Quantum Technology

"AI relies on the ability to crunch huge stacks of information, which is where quantum excels." —Time magazine

The intersection of artificial intelligence (AI) and quantum technology presents a profound convergence, unlocking unprecedented potential in financial services. Quantum computing can significantly augment AI algorithms' performance, while AI can optimise quantum algorithms.

Key Benefits:

- Enhanced data processing capabilities
- Improved risk management
- Personalised financial products and services
- Advanced security measures

Implementation Challenges:

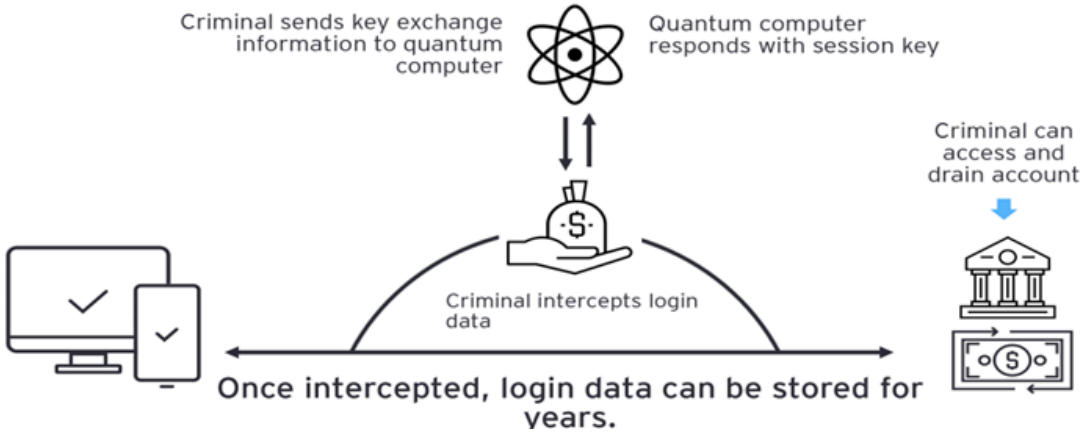
- High cost of quantum computing infrastructure
- Regulatory compliance concerns

Future Implications:

- Redefining the competitive landscape
- Urgent need for quantum-resistant security measures, including post-quantum cryptography (PQC) and zero-trust architectures.

The Quantum Security Challenge

The most pressing concern is the ***"harvest now, decrypt later"*** attack, where adversaries are already collecting encrypted data to decrypt once quantum computers become sufficiently powerful. This particularly endangers data requiring long-term confidentiality, such as government communications and intellectual property



Source: https://www.ey.com/en_us/insights/strategy/financial-services-cybersecurity-for-quantum-computing

Why Now?

Data is the most valuable asset for any organisation. Sensitive data can remain vulnerable for over 10 years, and critical data for 25 years or more. This shows that today's encryption still poses a risk in the coming years

Security Imperatives

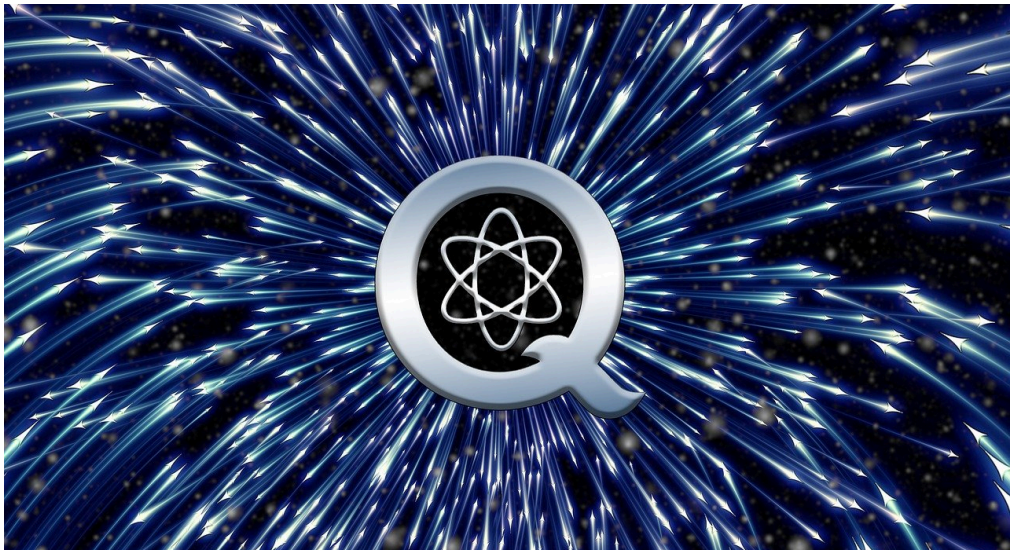
- **Post-quantum cryptography (PQC)**: Developing new mathematical algorithmic approaches to reinforce existing cryptographic protocols.
- **Quantum Safe Cryptography**: Leveraging quantum mechanical principles to create resilient systems, including Quantum Key Distribution.

Post-Quantum Cryptography (PQC): The Future of Cryptography

The looming threat of quantum computing to current encryption methods necessitates the adoption of Post-Quantum Cryptography (PQC). PQC is designed to resist attacks from both classical and quantum computers, ensuring the long-term security of digital services.

Key Challenges in Implementing PQC

- **Lack of "Crypto Agility":** Many tech stacks lack the flexibility to easily replace existing encryption algorithms with PQC alternatives.
- **Widespread Use of Current Encryption Methods:** Current encryption methods, such as RSA and ECC, are widely used across various systems, making it difficult to transition to PQC.
- **Complex Interdependencies:** Digital ecosystems often have complex interdependencies, making it challenging to implement PQC without disrupting existing systems.



Post Quantum Government Initiatives by Country and Region

Region	Key Guidelines	Timeline
North America	- US: NIST standards adoption - Canada: Awaiting standards	US: 2023-2033 Canada: Planning phase
Europe	- EU: NIST + EU-specific algorithms - Czech Republic: NIST-based - France/Germany: Not restricted to NIST - Netherlands: Hybrid mode focus	EU: Roadmap by 2026 Czech: By 2027 France: From 2024 Spain: Through 2030
Asia-Pacific	- China: Country-specific standards - Japan: NIST monitoring - Singapore: NIST monitoring - Australia/NZ: NIST alignment	China: Planning phase Japan: In development NZ: From 2026-27

Future-proofing digital financial services

The Reserve Bank Innovation Hub recommends that Indian banks proactively transition to post-quantum cryptography (PQC) algorithms:

- Quantum computing threatens to break existing encryption methods
- Post-quantum cryptography (PQC) offers a solution to this potential vulnerability
- Indian banks are advised to begin transitioning to PQC algorithms

Demystifying Quantum Technology

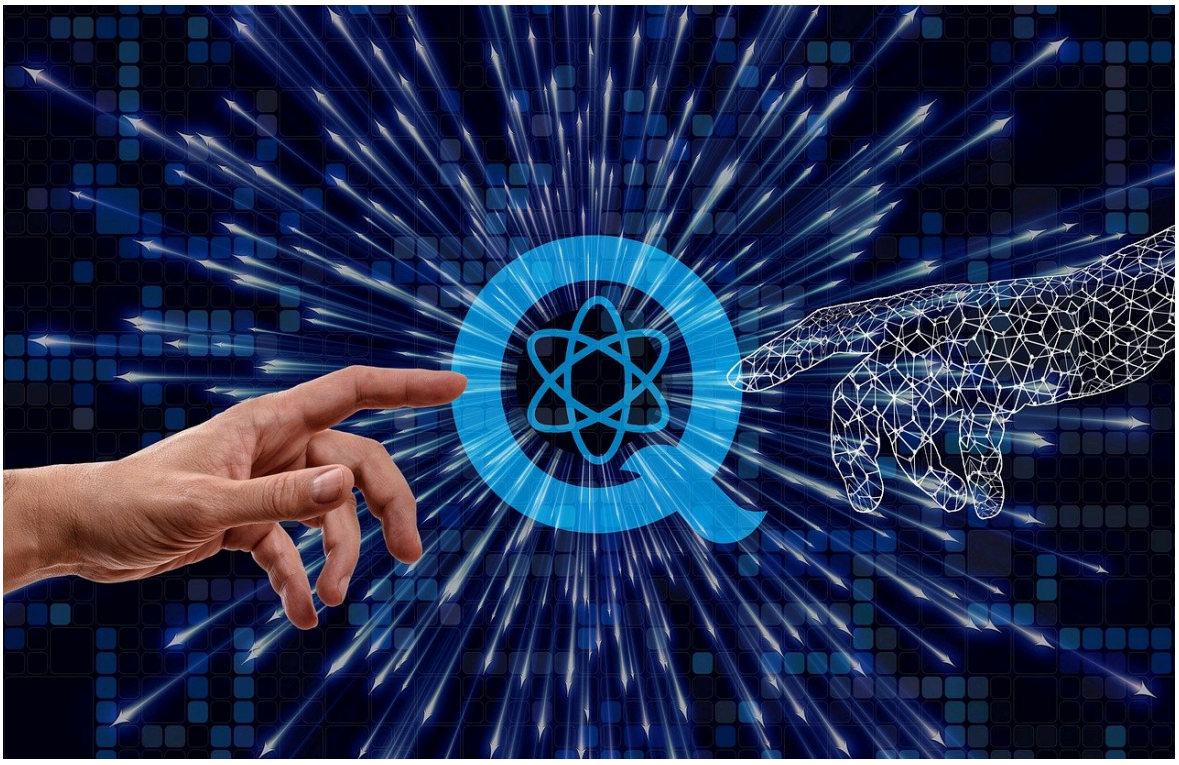
Quantum technology is a revolutionary field that harnesses the principles of quantum mechanics to drive groundbreaking advancements in various sectors. By leveraging the unique phenomena of quantum theory, such as entanglement and quantum tunnelling, quantum technology has the potential to transform industries and solve complex global challenges.

Key Principles and Pioneers:

- Quantum mechanics: a fundamental theory in physics
- Pioneers: Niels Bohr, Max Planck, Albert Einstein, Paul Dirac, and Erwin Schrödinger

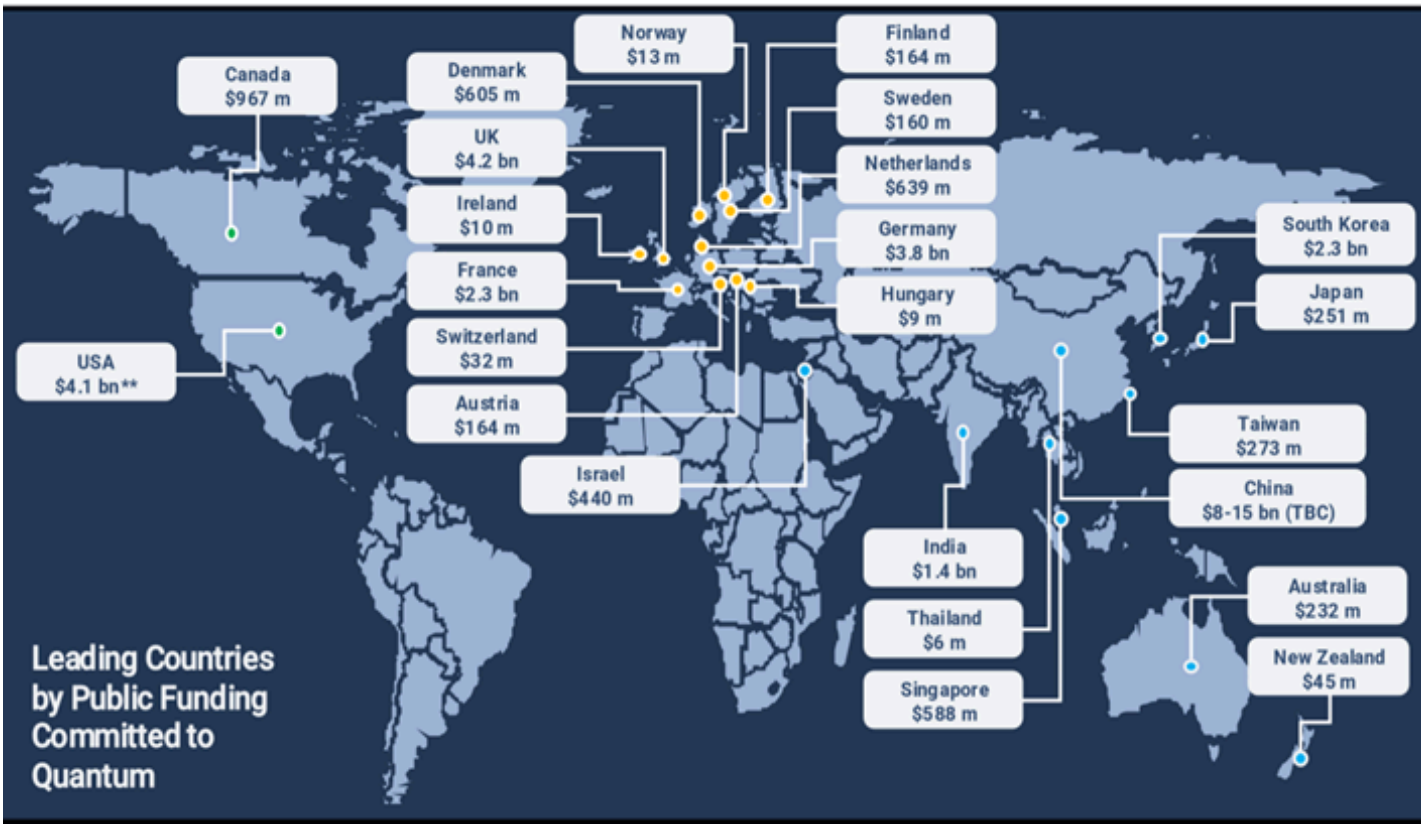
Applications of Quantum Technology:

- Artificial Intelligence: enables development of more efficient AI algorithms
- Quantum Computing: enables faster and more efficient processing of complex calculations
- Quantum Communication: enables secure communication through quantum encryption



Quantum Technology: Global Landscape

Public investments commitments by a few of leading nation continued to lead quantum development efforts in 2024



Source : Annual Report: The Quantum Economy, The Quantum Insider / Resonance

Quantum Computing

Quantum computing leverages quantum mechanical phenomena like superposition and entanglement:

- Qubits can represent multiple states simultaneously, enabling parallel processing
- Quantum computers solve specific problems exponentially faster than classical computers
- Potential applications in finance include complex simulations, optimisation problems, and machine learning

A conventional computer needs

300 trillion years

to crack RSA 2048 prime number factor encryption

A 4,099-qubit quantum computer would need

10 seconds

to crack the same RSA key.

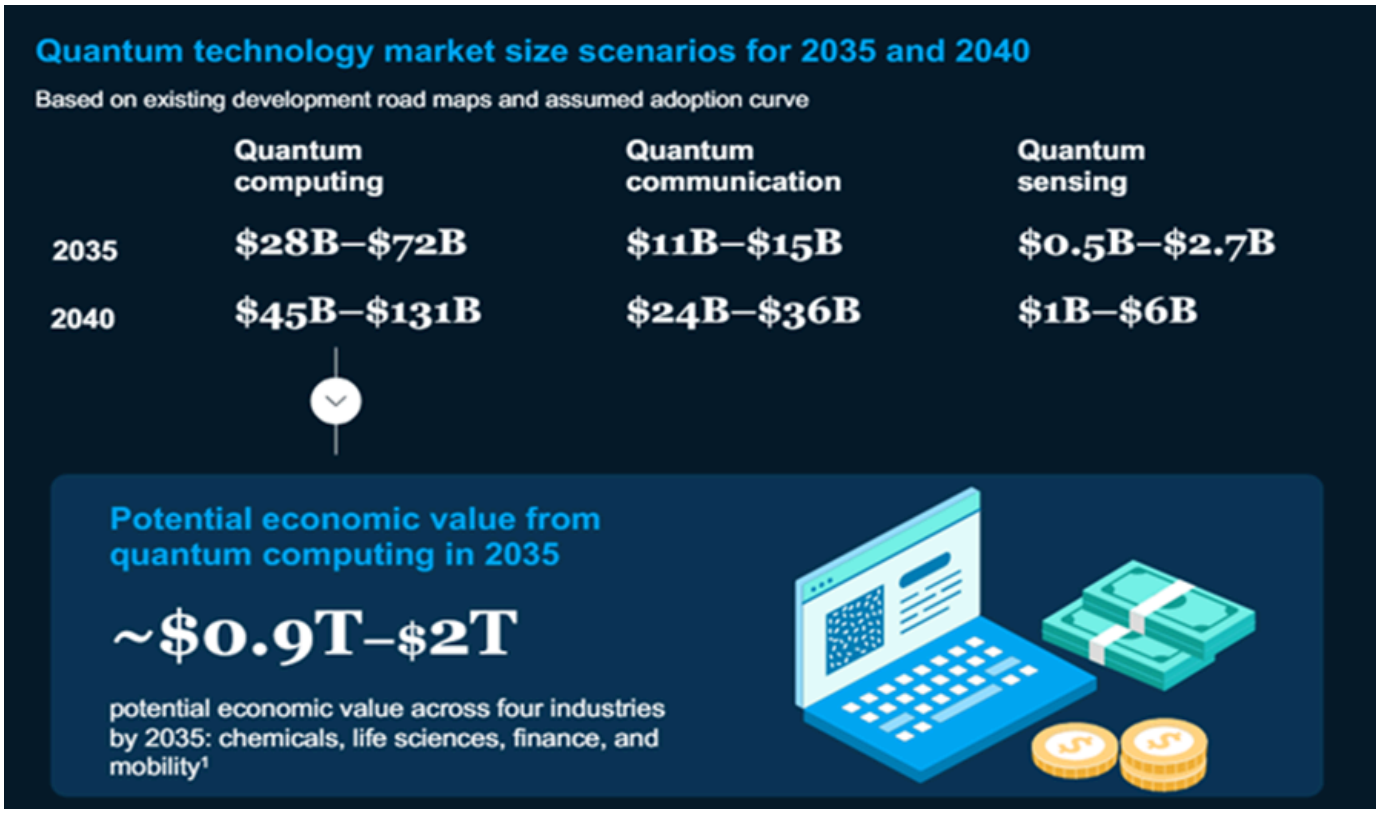
Source:: Baumhof, Andreas, "Breaking RSA Encryption – an Update on the State-of-the-Art," QuintessenceLabs website

Real-World Quantum Applications

- HSBC: Optimising portfolios and fraud detection
- JP Morgan: Enhancing financial modeling and risk assessment
- Goldman Sachs: Streamlining financial instrument pricing
- Wells Fargo: Revolutionising banking with AI and quantum integration
- Munich Re: Developing Quantum Risk Models with Germany's Quantum Technology Consortium
- AXA: Accelerating contract evaluations with Quantum Algorithms

Quantum Technology : Economic value

According to the Quantum Technology Monitor, the projected economic value for the following industries: chemicals, life sciences, finance and mobility will be to the tune of 0.9 trillion to 2 trillion[1].



Regulatory Considerations

Regulators must prepare for the quantum era:

- Establish quantum regulatory forums for knowledge sharing
- Develop application-specific regulatory frameworks
- Invest in quantum literacy for regulators and policymakers
- Promote international collaboration on quantum standards
- Implement quantum risk assessments in cybersecurity regulations

Navigating the Quantum Shift for Financial Services

Financial institutions should:

- Engage leadership in quantum awareness and strategy development
- Conduct thorough cryptographic assessments
- Invest in quantum education and skill development
- Stay informed on regulatory changes and engage with policymakers
- Implement quantum-safe technologies and collaborate across sectors

***Quantum Safe is "the use of cryptographic algorithms or protocols that helps secure the data that we have today. A lot of that is done using math. What quantum has the ability to do is take certain math problems and more efficiently than classical computers, render those security-vulnerable". ~* Steve Suarez, founder and CEO at Horizon Consulting**

Challenges and Risks of Quantum Computing in financial services

The financial sector faces significant challenges as quantum computing advances. Key areas of concern:

1. **Cryptographic Vulnerabilities**: Quantum computers can break traditional encryption, threatening customer data and market stability.
2. **Market Stability Risks**: Early adopters may gain unfair advantages, leading to market imbalances.
3. **Skills Deficit**: A shortage of quantum technology experts hinders the sector's ability to leverage quantum computing.
4. **Technological Debt**: Transitioning to quantum-safe systems while managing existing infrastructure is a significant challenge.
5. **Ethical and Environmental Concerns:** Quantum computing raises ethical concerns and environmental impact issues.

Key considerations for PQC implementation

- Act now: Adopt PQC before large-scale quantum computers emerge.
- Comprehensive approach: Implement quantum-resistant systems across all critical infrastructure.
- Regulatory focus: Establish cross-sectoral taskforces to address quantum challenges.
- Develop talent: Invest in education and training for quantum technology experts.
- Global cooperation: Collaborate internationally to develop consistent standards and approaches.

Q-Action Plan for Indian Financial Services

Recommendations for India's financial sector:

- Establish a National Quantum Finance Task Force
- Invest in quantum education and skill development
- Foster industry-academia collaboration for quantum finance research
- Develop India-specific use cases and proof-of-concept projects
- Leverage the country's IT workforce and startup ecosystem

Recommendations & Next Steps

1. **Leadership:** Organisations must apprise board members and senior executives about quantum computing's impact, this will ensure quantum security considerations are integrated into strategic decisions, fostering organisational readiness and proactive risk management.
2. **Strategy :** Develop comprehensive quantum strategies and roadmaps, including thorough assessments of current cryptographic landscapes.
3. **Task force:** Establish regulatory frameworks and cross-sectoral taskforces to address quantum-specific challenges in finance, including the implications of quantum computing and AI.
4. **PQC:** Prioritise the implementation of Post-Quantum Cryptography (PQC) across all critical infrastructure.
5. **PPP :** Foster effective public-private partnerships to harness the potential of quantum technology & AI, enabling the coordination of research agendas, investment strategies, and regulatory policies.
6. **Quantum literacy**: Invest heavily in quantum education and skill development to bridge the talent gap, with a focus on interdisciplinary expertise in quantum computing and AI.
7. **Collaboration** : Foster industry-academia collaborations to accelerate quantum finance applications and QAI research.

Conclusion

The financial services industry faces a critical moment. Embracing quantum technologies and Post-Quantum Cryptography (PQC) strategically will yield significant competitive advantages.

The quantum revolution in finance is unfolding now.

Financial institutions that act swiftly to embrace quantum technologies, including quantum computing and AI, will not only safeguard their operations but also gain significant competitive advantages in this rapidly evolving landscape. The time for strategic action is now, as the industry prepares to harness the transformative power of quantum computing while mitigating its associated risks.

Appendix

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About us

KQUANTA RESEARCH

Kquanta Research stands at the forefront of innovation, occupying a unique space at the intersection of finance, artificial intelligence, quantum technology, and sustainability. As an independent research firm, we are dedicated to bridging the gap between cutting-edge technologies and their practical applications in the financial services sector.

Our Mission

Our mission is to accelerate the adoption of transformative technologies in the financial industry, with a particular focus on the Indian market and fostering global collaborations. We aim to be the catalyst that brings together technology innovators, academic researchers, and industry leaders to shape the future of finance.

Our value proposition

- Interdisciplinary Expertise: We bring together insights from finance, AI, quantum computing, and sustainability to offer a holistic perspective on the challenges and opportunities facing the financial sector.
- Bridge Builders: We serve as the crucial link between academia, technology developers, and industry practitioners, facilitating knowledge transfer and collaboration.
- Focus on India: While maintaining a global outlook, we specialise in understanding and addressing the unique needs and potential of the Indian financial market.
- Global Collaboration: We actively work to enhance international partnerships, bringing the best global practices to India and showcasing India's innovations to the world.
- Future-Focused Research: Our independent research helps financial institutions, policymakers, and technology companies navigate the complex landscape of emerging technologies and their implications for finance.
- Sustainability Integration: We recognise the critical role of sustainable practices in the future of finance and work to integrate environmental, social, and governance (ESG) considerations into technological advancements.

Our Approach

- Comprehensive Research: We conduct in-depth, independent research on the latest developments in AI, quantum computing, and sustainable finance.

- Collaborative Networks: We cultivate a robust network of academics, tech innovators, and industry leaders to foster cross-sector collaborations.

- Policy Advocacy: We engage with policymakers to promote frameworks that encourage innovation while ensuring responsible use of advanced technologies in finance.

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