



Engineering and Technology Quarterly Reviews

Osiobe, E. U., Hammood, W. A., Malallah, S., Osiobe, N. E., Hammood, O. A., & Asmara, S. M. (2025), Quantum Computing and the Next Technological Revolution: Transforming Civilization Through Quantum Power. In: *Engineering and Technology Quarterly Reviews*, Vol.8, No.2, 28-34.

ISSN 2622-9374

The online version of this article can be found at:
<https://www.asianinstituteofresearch.org/>

Published by:
The Asian Institute of Research

The *Engineering and Technology Quarterly Reviews* is an Open Access publication. It may be read, copied, and distributed free of charge according to the conditions of the Creative Commons Attribution 4.0 International license.

The Asian Institute of Research *Engineering and Technology Quarterly Reviews* is a peer-reviewed International Journal. The journal covers scholarly articles in the fields of Engineering and Technology, including (but not limited to) Civil Engineering, Informatics Engineering, Environmental Engineering, Mechanical Engineering, Industrial Engineering, Marine Engineering, Electrical Engineering, Architectural Engineering, Geological Engineering, Mining Engineering, Bioelectronics, Robotics and Automation, Software Engineering, and Technology. As the journal is Open Access, it ensures high visibility and the increase of citations for all research articles published. The *Engineering and Technology Quarterly Reviews* aims to facilitate scholarly work on recent theoretical and practical aspects of Education.



ASIAN INSTITUTE OF RESEARCH
Connecting Scholars Worldwide

Quantum Computing and the Next Technological Revolution: Transforming Civilization Through Quantum Power

Ejiro U Osiobe¹, Waleed A. Hammood², Safia Malallah³, Nyore E. Osiobe⁴, Omar Abdulmaged Hammood⁵,
Salwana Mohamad Asmara⁶

¹ The Ane Osiobe International Foundation

² Information Technology Department, College of Computer Science and Information Technology
University of Anbar, Ramadi, Iraq

³ Department of Computer Science, Kansas State University

⁴ The Ane Osiobe International Foundation

⁵ Business Administration Department, Faculty of Administration and Economics, University of Fallujah, Iraq

⁶ Faculty of Computing, Universiti Malaysia Pahang AI-Sultan Abdullah, Pekan, Malaysia

Abstract

Quantum mechanics principles underpin quantum computing, signaling a major shift in how we process information. While it offers immense processing power and potential advantages, it also presents significant challenges for the cryptocurrency industry. This sector has grown rapidly, supporting decentralized finance and empowering users worldwide, but it also attracts malicious actors looking to exploit its vulnerabilities. Traditional cryptography remains strong, yet increasingly sophisticated computational attacks threaten security. As the cryptocurrency market expands, quantum computing offers both opportunities, such as improved transaction security, and risks, like easier decryption for hackers. Understanding quantum technology's benefits and challenges is crucial as it develops. Currently, data is protected by traditional cryptography, but future, more powerful quantum computers could weaken this security. This article explores potential uses of quantum computing in daily life and business, explains its functions simply, and discusses societal impacts. Its goal is to help students and general readers understand how quantum technology might transform our world through clear language and real-life examples. Topics include the basics of quantum computing, its present and future applications across industries, and its societal effects. We provide a thorough analysis of how quantum computing could reshape society through mathematical insights, practical examples, and future perspectives.

Keywords: Quantum Computing, Cryptocurrency, Decentralized Finance, Future Computing of Things, Modern Computing, Edge AI, Edge computing, Artificial Intelligence, Machine Learning, Cloud computing, Quantum computing, Computing

1. Introduction

Superposition, entanglement, and interference are core principles of quantum mechanics that underpin quantum computing, enabling calculations beyond what traditional computers can achieve. Qubits can simultaneously exist in multiple states, unlike classical bits that are either 0 or 1, leading to exponentially increased parallel processing. This technology has promising applications in areas such as drug discovery, financial modeling, optimization, economic growth, and development, often involving data-driven proposals to maximize AI and human utility. As research advances, integrating AI—especially generative AI—with quantum computing could enable breakthroughs. Cryptocurrencies rely heavily on cryptographic algorithms to secure transactions and protect identities, but these encryption methods could be vulnerable to quantum attacks that leverage superposition and entanglement. For instance, Shor's algorithm can efficiently factor large numbers, threatening elliptic curve cryptography (ECC) and RSA (Paloalto Networks, 2025). Similarly, Grover's algorithm might hasten the discovery of hash collisions, endangering blockchain security mechanisms like proof-of-work (Kearney & Perez-Delgado, 2025). This poses a significant security challenge for cryptocurrencies such as Ethereum and Bitcoin.

Over the past 60 years, improvements in computer hardware have driven technological progress. Throughout this period, newer models and innovations have progressively replaced older technologies, shaping today's tech environment. The Internet, serving as a broad platform for interactive devices, has played a key role in social, economic, and technological breakthroughs in the 21st century. As reliance on computing resources has increased, these systems have become more complex and widespread, leading to the development of new computer systems (Gill et al., 2024). Rapid technological advancements have significantly upgraded the capabilities and user expectations for computing devices. For example, early mainframes combined transmission interfaces for user input with centralized data processing and storage. Innovations such as clusters, packet-switching, microchip devices, and Graphical User Interfaces (GUIs) facilitated the shift from large, centrally operated mainframes to personal computers. The global adoption of network standards has enabled interconnected networks worldwide to communicate and share data effectively.

Businesses are increasingly combining sensor and actuator functions with network connectivity by creating designs and standards that assign tasks to remote compute resources like memory, storage, and data processing. As a result, emerging ideas such as edge computing and the Internet of Things (IoT) are pushing technology beyond traditional network centers. Over the past 60 years, computing models have undergone a fundamental shift to address societal and system design challenges. Despite the transition from mainframes to workstations, cloud computing, and decentralized systems like edge computing and IoT, their core features have remained consistent. All are founded on computing research, with advances in security, edge technology, hardware acceleration, and energy efficiency driving progress and innovation across many industries. To meet new system integration challenges and opportunities, a significant amount of software framework development has taken place, including middleware, network protocols, and secure segregation techniques, supporting emerging systems and novel applications.

The crypto industry is exploring quantum-resistant cryptographic algorithms that remain secure against both classical and quantum attacks to address quantum threats. Post-quantum cryptography protocols are actively being developed and standardized by organizations such as the National Institute of Standards and Technology (NIST) (Kennedy, 2024). Transitioning to these algorithms requires replacing current cryptographic standards with new ones capable of resisting quantum computing threats. This shift is crucial for cryptocurrency platforms to stay secure and sustainable long-term. Besides encryption, quantum computing can greatly improve fraud detection. Quantum algorithms can analyze large datasets incredibly fast, uncovering trends and anomalies indicative of fraud. Quantum-enhanced machine learning models, for example, can detect suspicious transactions that may suggest money laundering or market manipulation, such as rapid coin transfers or unusual trading volumes (Weinberg & Faccia, 2024). Additionally, quantum computing can improve risk assessment models for real-time evaluation of user behavior and transaction legitimacy. This proactive approach allows platforms to identify threats early, protecting users and maintaining system trust.

Quantum computing (QC) offers a groundbreaking way to analyze data and knowledge. By encoding information in quantum states within specialized devices, data processing becomes possible in methods unattainable with

classical technology (Gill et al., 2022). Phenomena like quantum entanglement and superposition demonstrate this potential. Entanglement complicates the complete description of a system based on individual parts alone, while superposition allows states to combine into new, valid configurations. Initially aimed at modeling quantum systems, the focus shifted after the discovery of useful quantum algorithms. The crypto industry now explores quantum-resistant cryptography to withstand both classical and quantum threats, addressing quantum risks. Organizations like the National Institute of Standards and Technology (NIST) are developing and standardizing post-quantum cryptography protocols (Kennedy, 2024). Transitioning involves replacing current cryptographic standards, crucial for the security of cryptocurrency platforms. Additionally, quantum computing can greatly improve fraud detection by rapidly analyzing large datasets for patterns and anomalies, aiding in the detection of money laundering or market manipulation through suspicious transaction patterns. Quantum-enhanced machine learning models also help identify unusual transactions, such as sudden coin movements or trading volume spikes. Furthermore, quantum computing can refine risk assessment models used for real-time evaluation of user behavior and transaction validity, supporting early threat detection and preserving user trust and system integrity.

2. Quantum computing and AI

The quantum bit, or qubit, is essential to quantum computing. One way to express a single qubit is:

$$|\partial\rangle = \gamma|0\rangle + \beta|1\rangle$$

Where:

Normalized complex numbers are represented by γ and β .

A qubit can exist in a combination of 0 and 1 states simultaneously thanks to superposition. These qubits are manipulated by quantum gates to perform calculations, and quantum circuits solve complex problems.

Where:

$$|\gamma|^2 + |\beta|^2 = 1$$

Quantum computing is based on the core principles of quantum physics, which explain the behavior of particles at microscopic scales. In a quantum computer, superposition allows qubits—capable of representing both 0 and 1 at the same time—to hold information. This enables quantum computers to perform calculations much faster than classical ones, making them ideal for complex simulation and optimization tasks. Quantum computing provides several significant benefits. It can process large data volumes simultaneously, which is essential for real-time decision-making in Internet of Things (IoT) environments. They can also execute advanced AI algorithms more efficiently than traditional systems, resulting in quicker and more accurate inferences. Furthermore, quantum computing has the potential to revolutionize encryption methods used in IoT devices. Quantum cryptography offers security levels that are nearly impossible to breach with conventional techniques, thus protecting sensitive IoT data. However, quantum-based AI inference faces hurdles, mainly the scarcity of quantum hardware, which hampers scaling for extensive IoT applications. Additionally, creating and operating quantum systems demands specialized expertise, presenting implementation challenges for certain businesses.

3. Deep learning and quantum computing

QC is developing next-generation advanced computational technologies aimed at tackling global challenges. This rapidly expanding field, gaining recognition within the scientific community, leverages quantum mechanics principles to solve complex problems in optimization and machine learning. Quantum computers have enabled the development of quantum algorithms that, for certain problems, can deliver exponential speedups compared to classical methods. However, QC faces limitations due to its still-evolving technology. Combining traditional and quantum computing to create hybrid pattern recognition algorithms offers a practical solution for defect analysis and diagnosis. Besides significant performance improvements over classical computers, quantum computing presents innovative approaches to difficult problems. For instance, Grover's quantum search algorithm can find an item in a large database in the square root of the database size, and Shor's algorithm can factor numbers exponentially faster than classical methods. Quantum advantages are anticipated in fields such as quantum chemistry, machine learning, encryption, and optimization. Recent progress in quantum algorithms and hardware allows quantum computers to handle complex energy system optimization tasks, including process integration and superstructure optimization, which are crucial for designing sustainable energy solutions. These problems' high complexity usually requires traditional optimization solvers, often computationally expensive and without

guaranteed solutions. Large-scale renewable energy system optimization demands substantial computing resources. Developing hybrid QC-based deep learning architectures for effective defect detection (Ajagekar & You, 2019) involves several challenges: building defect diagnostic systems that combine decision and classification techniques with feature extraction, creating fast training methods using both QC and classical computers for better parameter estimation, addressing limited data diversity that affects fault diagnosis accuracy, and ensuring scalability to process large datasets without losing performance.

4. Basics of quantum computing

Quantum computing, defined as computing based on quantum mechanics principles, is poised to be the next major development in technology. Over the last fifty years, Moore's law has largely held, with computing power doubling roughly every two years as transistor sizes shrink on integrated circuits. Today's most advanced transistors are just a few atoms thick, yet quantum effects start to impact their behavior as dimensions decrease (Ajagekar & You, 2021). The key component of quantum computing is the qubit, similar to the classical bit—the basic unit of data. Unlike a classical bit, which is either 0 or 1, a qubit can exist in a superposition of states $|0\rangle$ and $|1\rangle$, called the computational basis states.

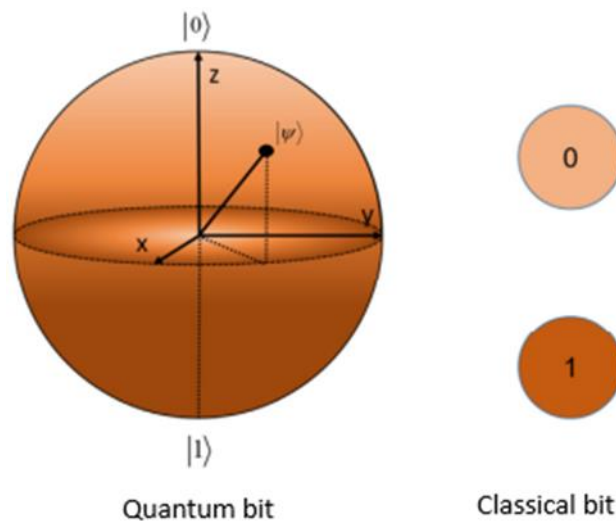


Figure 1: Fundamental units of computing

A key feature distinguishing qubits from classical bits is entanglement. This phenomenon enables correlations between two qubits' independently random behaviors. The properties of superposition and entanglement are exploited in quantum computers to achieve high computational power. Advances in technology have made certain quantum computing architectures feasible. Below is a brief overview of the functions and applications of various quantum computing technologies.

5. Current Applications and Outlooks

Numerous efforts are already underway to incorporate quantum computing into cryptocurrency security systems. For instance, the European bank Intesa Sanpaolo is exploring quantum machine learning techniques to improve its fraud detection methods, aiming for more accurate and faster identification of suspicious activity. Additionally, the AWS and Deloitte partnership: Using Amazon Bracket, Deloitte Italy and AWS have developed a fraud detection system based on quantum neural networks (SEC, 2025). This system demonstrates how quantum computing can be used to detect anomalies in digital payments, including cryptocurrency transactions (Marini et al., 2024).

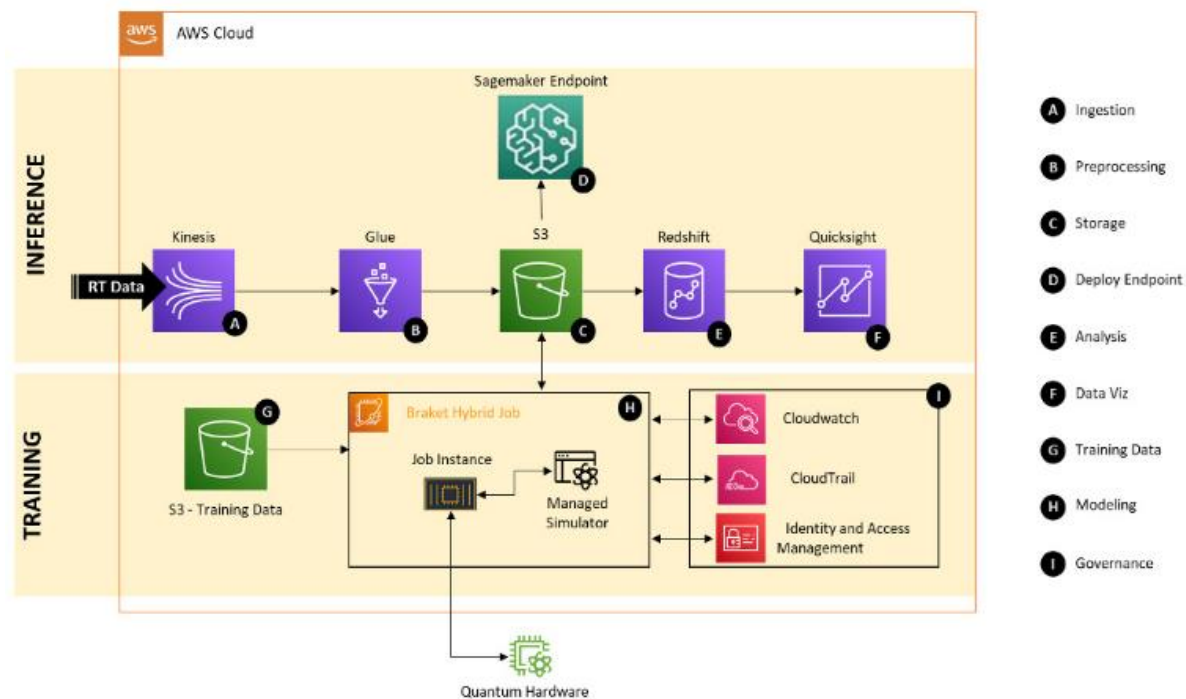


Figure 2: Marini et al, 2024 Architecture Solution of a Neural Network-Based Fraud Detection

The diagram below illustrates the solution architecture for deploying a neural network-based fraud detection system using AWS services. The approach employs a hybrid quantum neural network, built with the Keras library, while PennyLane handles the quantum component (Marini et al., 2024).

6. Predictions for each industry

Quantum computing, by simulating complex molecular interactions and structures, could revolutionize drug discovery in healthcare. Researchers are developing hybrid quantum systems to overcome challenges like calculating Gibbs free energy profiles for prodrug activation and modeling covalent bonds. As Li et al. (2024) mention, these innovations aim to accelerate new therapies and personalized medicine. Additionally, quantum computing promises to improve risk assessment and portfolio management in finance by processing complex models more efficiently than traditional methods, resulting in faster insights and better predictions. In logistics, hybrid approaches combining gate-based methods and quantum annealing address complex routing problems, such as drone navigation, by integrating clustering with real-world constraints (Osaba et al., 2025). The synergy of AI and quantum computing opens new horizons: quantum-enhanced AI can analyze large datasets faster, improving predictions. Researchers at IonQ show how quantum-enhanced generative adversarial networks (QGANs) can enhance material properties. For environmental data, quantum computing could significantly improve climate models, leading to more accurate forecasts and better climate change mitigation. When combined with AI, it further strengthens the analysis of complex environmental systems. Soller et al. (2025) predict the quantum industry might reach a valuation between \$28 billion and \$72 billion by 2035, transforming sectors like computing, communication, and sensing. This growth underscores the profound societal and industrial impact quantum technologies are expected to have, with anticipated integration into platforms like cryptocurrency systems by 2035.

Standardize quantum-resistant protocols to safeguard transactions across all platforms as post-quantum cryptography algorithms grow in popularity. Deploy advanced fraud detection systems enabled by quantum analytics for real-time prevention, reducing losses and enhancing user trust. Collaborate with governments and regulators to develop regulatory frameworks that establish standards and guidelines for quantum-safe cryptocurrencies, promoting a secure and compliant ecosystem. As quantum computers become commercially available soon, their applications will expand into logistics, healthcare, and finance. Integrating AI with quantum computing will accelerate machine learning, enabling more detailed data analysis and better decision-making.

Quantum computing also aims to support environmental initiatives by improving resource management and climate modeling. Additionally, the industry is expected to generate significant economic growth through innovation and job creation. Quantum-powered precision medicine will facilitate highly personalized treatments tailored to each patient's genetic profile. Advanced quantum models predicting disease progression and susceptibility will aid early detection, leading to more effective interventions. Quantum computing will enable real-time market analysis, rapid trading decisions, and transform financial markets. Quantum-based fraud detection algorithms will identify illegal activities across extensive financial networks. Autonomous logistics, such as self-driving delivery trucks, will become more feasible with quantum computing. Furthermore, quantum networks will improve global supply chain management by increasing responsiveness and resilience.

The development of Artificial General Intelligence (AGI) will heavily depend on quantum computing, which provides the vital computational power needed for advanced learning and reasoning. AI systems integrated with quantum technology will become more adaptable and capable of solving complex problems. Educational institutions will incorporate quantum computing topics into their curricula, nurturing a new generation of quantum technology experts. Moreover, immersive quantum simulations will enable students to better interact with and comprehend complex systems. Smart factories will leverage quantum computing to create self-optimizing manufacturing processes. Advanced robotics equipped with quantum technology will establish more flexible and efficient production lines. The emergence of innovative quantum materials aimed at enhancing energy storage—known as "Quantum-Enhanced Energy Storage"—is poised to revolutionize the energy sector. Additionally, quantum computing will support the development of global energy networks that efficiently manage supply and demand across regions. In agriculture, quantum computing will facilitate precision farming, increasing yields while conserving resources.

Advancements in quantum technologies will drive the development of climate-resilient crops that can withstand environmental changes. Autonomous vehicles, such as drones and self-driving cars, will gain improved capabilities through quantum tech. Quantum networks will enable seamless integration into transportation systems, increasing efficiency. The telecom industry will see the emergence of quantum internet, offering ultra-secure data transfer and global connectivity. Implementing quantum-resistant cryptography will strengthen digital security. Moreover, quantum computing will facilitate real-time detection and response to cyber threats. In entertainment, it will boost immersive experiences by supporting more engaging virtual and augmented reality environments. Generating dynamic, user-interactive content will become easier with quantum models. Retailers will introduce adaptive stores that instantly respond to customer needs, and quantum-enabled tracking will enhance supply chain transparency, improving both efficiency and trust. In construction, quantum tech will support 自动化 building processes and eco-friendly design. Aerospace will benefit from quantum navigation systems for precise spatial positioning and better analysis of large datasets for space exploration.

7. Conclusion

Quantum computing encounters challenges such as qubit coherence, high error rates, and the necessity for cryogenic temperatures. As the field progresses, ethical concerns like data security, privacy, and automation of jobs also come to the forefront. Despite these hurdles, quantum computing is moving from theoretical research to practical use, revolutionizing various industries. Ideas once considered science fiction are now becoming reality, especially with the integration of quantum technology with AI and other innovations. Although the technology presents specific difficulties for cryptocurrencies, it also opens up opportunities to enhance security and combat fraud. By implementing quantum-resistant solutions and leveraging advanced quantum analytics, the crypto industry can safeguard its future and create a trustworthy, resilient environment for users.

Author Contributions: All authors contributed to this research.

Funding: Not applicable.

Conflict of Interest: The authors declare no conflict of interest.

Informed Consent Statement/Ethics Approval: Not applicable.

Declaration of Generative AI and AI-assisted Technologies: This study has not used any generative AI tools or technologies in the preparation of this manuscript.

References

- Ajagekar, A., & You, F. (2019). Quantum computing for energy systems optimization: Challenges and opportunities. *Energy*, 76-89.
- Ajagekar, A., & You, F. (2021). Quantum computing based hybrid deep learning for fault diagnosis in electrical power systems. *Applied Energy*, 117628.
- Gill, S. S., Kumar, A., Singh, H., Singh, M., Kaur, K., Usman, M., & Buyya, R. (2022). Quantum computing: A taxonomy, systematic review and future directions. *Software; Practice and Experience*, 66 - 114.
- Gill, S. S., Wu, H., Patros, P., Ottaviani, C., Arora, P., Pujol, V. C., . . . Qadir, J. e. (2024). Modern computing: Vision and challenges. *Telematic and Informatic Reports*, 100-116.
- Hammood, W. A., Asmara, S. M., Rosli, M. M., Ghdhban, I. I., & Osiobe, E. U. (2025). Sensitivity Analysis of Electromechanical Impedance Signals for Early Detection of Debonding in Sandwich Face Layers: A Case Study Using SHM Data. *Mesopotamian Journal of Civil Engineering*, 1-19.
- Kearney, J. J., & Perez-Delgado, C. A. (2021). Vulnerability of blockchain technologies to quantum attacks. *Array*, 10, 1-10.
- Kennedy, A. (2024, 12 30). *Bank Policy Institute*. Retrieved from Quantum Computing: The Urgent Need to Transition to Quantum-Resistant Cryptography: https://bpi.com/quantum-computing-the-urgent-need-to-transition-to-quantum-resistant-cryptography/?utm_source=chatgpt.com
- Li, W., Yin, Z., Li, X., Ma, D., Yi, S., Zhang, Z., . . . Zhang, S. (2024). A Hybrid Quantum Computing Pipeline for Real World Drug Discovery.
- Marini, F., Capozzi, M., Muthu, K., & Singh, K. (2024, 7 17). *How Deloitte Italy built a digital payments fraud detection solution using quantum machine learning and Amazon Braket*. Retrieved from Amazon Web Services (AWS)-Artificial Intelligence: https://aws.amazon.com/blogs/machine-learning/how-deloitte-italy-built-a-digital-payments-fraud-detection-solution-using-quantum-machine-learning-and-amazon-braket/?utm_source=chatgpt.com
- Osaba, E., Miranda-Rodrigue, P., Oikonomakis, A., Petric, M., Ruiz, A., Bock, S., & Kourtis, M.-A. (2025). Solving Drone Routing Problems with Quantum Computing: A Hybrid Approach Combining Quantum Annealing and Gate-Based Paradigms.
- Osiobe, E. U. (2025). *An Economic Overview of the Nigerian Economy*.
- Osiobe, E. U. (2025). *Educating Our Girls*.
- Osiobe, E. U., Hammood, W. A., Malallah, S., Osiobe, N. E., Hammood, O. A., & Asmara, S. M. (2025). Quantum Computing: An Overview of its Potential to Revolutionize Civilization. *Missouri Iowa Nebraska Kansas Women in Computing*. Lenexa: MINK-WIC.
- Osiobe, E. U., Malallah, S., & Osiobe, N. E. (2024). Enhancing Data Visualization Accessibility: A Case for Equity and Inclusion. *Engineering and Technology Quarterly Reviews*, 24-32.
- Paloalto Networks. (2025). *What Is Quantum Computing's Threat to Cybersecurity?* Retrieved 6 19, 2025, from https://www.paloaltonetworks.com/cyberpedia/what-is-quantum-computings-threat-to-cybersecurity?utm_source=chatgpt.com
- Soller, H., Gschwendtner, M., Shabani, S., & Svejstrup, W. (2025, 9 15). *The Year of Quantum: From concept to reality in 2025*. Retrieved from McKinsey & Company: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-year-of-quantum-from-concept-to-reality-in-2025?utm_source=chatgpt.com
- U.S. Securities and Exchange Commission (SEC). (2025, 8 13). *The SEC Launches "Project Crypto"*. Retrieved from <https://www.sec.gov/about/sec-launches-project-crypto> and https://www.sec.gov/files/cft-written-input-daniel-bruno-corvelo-costa-090325.pdf?utm_source=chatgpt.com
- Weinberg, A. I., & Faccia, A. (2024). Quantum Algorithms: A New Frontier in Financial Crime Prevention.