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JOURNAL FAKULTAS HUKUM UNIVERSITAS SRIWIJAYA
JURIST CONCORDIA

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Jalan Srijaya Negara, Palembang, South Sumatra 30139, Indonesia.
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Website: https://journal.fh.unsri.ac.id/index.php/JCon

Quantum Computing and Legal Classification Under the Electronic Information and Transaction Framework

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Article

Keywords:

Quantum Computing, ITE Law, Electronic Systems, Information Technology, Juridical Classification.

DOI: xxx

Abstract

Quantum computing has emerged as a transformative computational paradigm that challenges legal frameworks developed for conventional electronic technologies. Its ability to process information through quantum mechanical principles, such as superposition and entanglement, raises questions regarding its legal classification under Indonesia's electronic information and transactions regime. This study analyzes the juridical status of quantum computing based on the legal concepts of Electronic Information, Electronic Documents, Electronic Systems, and Information Technology contained in Law Number 11 of 2008 concerning Electronic Information and Transactions, as amended. Employing normative legal research through statutory and doctrinal approaches, the study concludes that quantum computing cannot be classified as Electronic Information or an Electronic Document because it neither constitutes data nor represents information capable of meaningful interpretation and retrieval. Instead, it functions as a technological means of information processing. However, quantum computing satisfies the legal criteria of an Electronic System due to its integrated hardware, software, and operational components, and it also falls within the broader category of Information Technology. Accordingly, quantum computing should be understood as an Electronic System and a form of Information Technology under the Indonesian legal framework governing electronic information and transactions.

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INTRODUCTION

The development of digital technology in the twenty-first century has entered a new phase with the emergence of quantum computing as a computational paradigm distinct from classical

computing systems.[1] This technology utilizes quantum mechanical phenomena, such as *superposition*[2] and *entanglement*[3] to process information at a level of complexity far exceeding that of conventional computers. The potential of quantum computing to solve optimization problems, conduct scientific simulations, and perform cryptographic operations within exceptionally short periods has attracted significant attention from governments, industry stakeholders, and academic communities across the globe.[4] As a result, quantum computing is no longer regarded merely as a theoretical concept within the field of physics; rather, it has evolved into a technology that is increasingly entering the domains of public policy and legal regulation.[5]

The emergence of quantum computing presents challenges to legal frameworks that have traditionally been developed on the basis of the characteristics of conventional electronic technologies. The legal regime governing electronic information and electronic transactions was fundamentally designed to regulate activities involving electronic data, electronic systems, and the utilization of information technology within the digital environment.[6] As information processing is increasingly conducted through quantum mechanisms that differ fundamentally from traditional binary systems, a need arises to re-examine the continued relevance and applicability of existing legal concepts.[7] This issue is of particular importance because the legal definitions employed in statutory regulations determine the scope of applicability of legal norms to technologies that continue to evolve and develop.

In Indonesia, the Electronic Information and Transactions Law establishes a regulatory framework through the concepts of Electronic Information, Electronic Documents, Electronic Systems, and Information Technology. These concepts perform distinct yet interrelated functions in governing digital activities. Electronic Information is positioned as the object being processed, Electronic Documents serve as the medium through which information is embodied, Electronic

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[1] Abha Tamrakar and Rishabh Sharma, "Quantum Computing: A Comprehensive Review," *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 10, no. 3 (2019): 1634–42, https://doi.org/10.61841/turcomat.v10i3.14623.

[2] Superposition is a fundamental principle of quantum mechanics which provides that a quantum system may exist in a combination of multiple states simultaneously until a measurement is performed, at which point a particular state is revealed. For a more detailed discussion, see Chapter 1, page 4: Superposition, Entanglement and Interference in.Jack D. Hidary, *Quantum Computing: An Applied Approach* (Springer International Publishing, 2019), https://doi.org/10.1007/978-3-030-23922-0.

[3] Entanglement refers to a condition in which two or more quantum systems become interconnected in such a manner that the properties of each individual system depend upon their collective quantum state. This phenomenon may persist even when the systems are separated by considerable geographical distances. For a more detailed discussion, see Chapter 1, page 6 : Superposition, Entanglement and Interference in.John Preskill, "Quantum Computing in the NISQ Era and Beyond," *Quantum* 2 (August 2018): 79, https://doi.org/10.22331/q-2018-08-06-79.

[4] Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information: 10th Anniversary Edition* (Cambridge University Press, 2010).

[5] Aurelija Lukoseviciene, "Regulating Quantum Computers: Insights into Early Patterns and Trends in Academic Regulatory Conversations on the 'Quantum Revolution,'" *Law, Innovation and Technology* 17, no. 1 (2025): 241–70, https://doi.org/10.1080/17579961.2025.2469350.

[6] Irman Syahriar, "Revisi Undang-Undang Informasi Dan Transaksi Elektronik Dalam Dimensi Politik Hukum," *Jurnal Ilmu Hukum "THE JURIS"* 5, no. 1 (2018): 6–14, https://doi.org/https://doi.org/10.56301/juris.v5i1.183.

[7] Jeffery Atik and Valentin Jeutner, "Quantum Computing and Computational Law," *Law, Innovation and Technology* 13, no. 2 (2021): 302–24, https://doi.org/https://doi.org/10.1080/17579961.2021.1977216.

Systems function as the means of processing, while Information Technology constitutes the technological foundation that enables such processes to take place.[8] Nevertheless, the law does not provide specific provisions governing quantum technologies, thereby giving rise to questions concerning the most appropriate legal category within which quantum computing should be situated under the existing normative framework.

The legal status of quantum computing has likewise become a subject of discussion within international legal scholarship. A number of studies have highlighted the potential for significant disruption to digital security systems arising from the capability of quantum computers to break cryptographic algorithms that are currently widely employed in electronic communications.[9] Such discussions extend beyond the technical aspects of information security and encompass broader issues relating to data protection, legal liability, technology governance, and the sustainability of regulatory frameworks in the era of next-generation computing. The increasing attention devoted to the legal implications of quantum computing demonstrates that this technology bears direct relevance to the subject matter regulated under electronic information and electronic transactions law.[10]

Studies on quantum computing from the perspective of Indonesian law remain relatively limited when compared to the extensive developments in the fields of technology and computer science. Most existing discussions focus on technical capabilities, innovation opportunities, and strategies for national technological development. However, determining the juridical classification of a technology is of considerable importance, as it directly relates to the interpretation of legal norms, the application of legal obligations, and the identification of subjects and objects falling within the scope of regulatory frameworks.[11] The absence of studies specifically examining the legal position of quantum computing within the regime governing electronic information and electronic transactions may give rise to interpretive uncertainty once such technology becomes more widely adopted in Indonesia.

In light of these developments, an examination of the juridical classification of quantum computing within the legal regime of electronic information and electronic transactions is both relevant and necessary. This study seeks to analyze the characteristics of quantum computing and to assess their relationship with the legal concepts embodied in the Electronic Information and Transactions Law, namely Electronic Information, Electronic Documents, Electronic Systems, and Information Technology. It is expected that the findings of this study will contribute to the development of Indonesian cyber law doctrine while simultaneously enriching academic discourse on the adaptation of legal frameworks to quantum technologies, which are projected to become one of the principal foundations of future digital transformation.

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[8] Edmon Makarim, *Pengantar Hukum Telematika: Suatu Kompilasi Kajian* (Depok: RajaGrafindo Persada, 2005). hlm. 85-92

[9] Michele Mosca, "Cybersecurity in an Era with Quantum Computers: Will We Be Ready?," *IEEE Security & Privacy* 16, no. 5 (2018): 38–41, https://doi.org/10.1109/MSP.2018.3761723. hlm. 38-41

[10] Shereen Abu Ghazaleh et al., "Securing the Digital Future: A Proactive Legal Framework for Quantum Computing Challenges," *Journal of Cultural Analysis and Social Change*, December 30, 2025, 4843–50, https://doi.org/10.64753/jcasc.v11i1.4044.

[11] Mateo Aboy et al., *Quantum Technology Governance I* (Springer Nature, 2026), hlm. 1-18 https://doi.org/https://doi.org/10.1007/978-981-95-8371-3.

RESEARCH METHODS

This study employs a normative legal research method, focusing on the analysis of legal norms and concepts relating to the legal status of quantum computing within the regime governing electronic information and electronic transactions. The approaches adopted include a statutory approach, involving an examination of Law Number 11 of 2008 concerning Electronic Information and Transactions, as amended, together with other relevant legislation, and a conceptual approach aimed at analyzing the juridical meanings of the concepts of Electronic Information, Electronic Documents, Electronic Systems, and Information Technology in relation to the characteristics of quantum computing. The primary legal materials consist of statutory regulations, which are analyzed in conjunction with secondary legal materials comprising books, scholarly journal articles, and academic publications addressing cyber law and the governance of quantum technologies. All legal materials were collected through library research and subsequently analyzed qualitatively by employing systematic and teleological methods of legal interpretation in order to formulate legal arguments concerning the juridical classification of quantum computing within the framework of electronic information and electronic transactions law in Indonesia.

ANALYSIS AND DISCUSSION

1. The Concepts of Electronic Information, Electronic Documents, Electronic Systems, and Information Technology Under Indonesian Law

The development of digital technology has prompted Indonesian law to establish legal terminology capable of accommodating various forms of electronic activities.[12] Such regulation is primarily embodied in Law Number 11 of 2008 concerning Electronic Information and Transactions, as most recently amended by Law Number 1 of 2024. The enactment of this legal regime not only governs legal acts conducted through electronic media but also constructs a normative framework concerning the objects and subjects operating within the digital environment.[13] The concepts of Electronic Information, Electronic Documents, Electronic Systems, and Information Technology constitute the principal elements that determine the scope of applicability of the Electronic Information and Transactions Law to emerging technological developments.

The concept of Electronic Information is defined in Article 1(1) of the Electronic Information and Transactions Law as one or a set of electronic data, including but not limited to writings, sounds, images, maps, designs, photographs, Electronic Data Interchange (EDI), electronic mail, telegrams, telex messages, telecopies, and various other forms of data that may be understood by persons capable of comprehending them. This definition demonstrates that

[12] Sherly Nelsa Fitri, "Politik Hukum Pembentukan Cyber Law Undang-Undang Informasi dan Transaksi Elektronik di Indonesia," *Jurnal Justisia : Jurnal Ilmu Hukum, Perundang-undangan dan Pranata Sosial* 7, no. 1 (2022): 104, https://doi.org/10.22373/justisia.v7i1.12719.

[13] Muzakkir and Taufik Hidayat, "JURIDICAL REVIEW ARTICLE 27A OF LAW NUMBER 1 OF 2024 CONCERNING THE SECOND AMENDMENT TO LAW NUMBER 11 OF 2008 CONCERNING INFORMATION AND ELECTRONIC TRANSACTIONS," *Jurnal Hukum Samudra Keadilan* 19, no. 2 (2025): 238–49, https://doi.org/10.33059/jhsk.v19i2.10650.

Electronic Information is not regarded as a physical object but rather as a representation of data possessing communicative value and a particular meaning. Accordingly, the regulatory focus is directed toward the informational content embodied in electronic data rather than the medium in which such data is stored.

The concept of Electronic Information is closely linked to its evidentiary function in law. The Electronic Information and Transactions Law recognizes Electronic Information as a legally admissible form of evidence, provided that it satisfies certain requirements concerning its integrity and reliability. Such recognition expands the law of evidence, which had previously been oriented primarily toward physical documents. Ignasius Sumarsono Raharjo argues that Electronic Information acquires legal significance because it is capable of performing functions traditionally fulfilled by written information in modern transactions, particularly where economic activities are conducted through electronic networks.[14] Its evidentiary value derives from its capacity to demonstrate facts, intentions, or legal relationships that are capable of verification.

Unlike Electronic Information, which emphasizes the substantive content of data, the concept of an Electronic Document focuses on the medium or form through which information is presented. Article 1(4) of the Electronic Information and Transactions Law defines an Electronic Document as any Electronic Information that is created, transmitted, sent, received, or stored in analog, digital, electromagnetic, optical, or other similar forms that may be viewed, displayed, and/or heard through a computer or an Electronic System. This definition indicates that an Electronic Document constitutes the tangible manifestation of Electronic Information that can be subsequently accessed for specific legal purposes. The relationship between the two concepts is complementary in nature: Electronic Information constitutes the content, whereas the Electronic Document serves as the form in which that content is embodied.

The concept of an Electronic System is specifically regulated under Article 1(5) of the Electronic Information and Transactions Law. An Electronic System is defined as a series of electronic devices and procedures that function to prepare, collect, process, analyze, store, display, publish, transmit, and/or disseminate Electronic Information. This definition demonstrates that the law governs not only the data being exchanged but also the infrastructure that enables such data to be processed and transmitted. In his research, Angga Priancha[15] characterizes an Electronic System as a construct comprising technological devices, operational mechanisms, and automated processes that generate particular electronic actions. Its scope encompasses hardware, software, networks, and various automated mechanisms that support digital activities.

The concept of an Electronic System is closely related to the notion of Information Technology, a term employed throughout various Indonesian legislative instruments. The elucidation of the Electronic Information and Transactions Law describes Information Technology as techniques used to collect, prepare, store, process, publish, analyze, and

[14] Ignasius Sumarsono Raharjo, "Informasi Elektronik Pada Transaksi Electronic-Commerce Dalam Hukum Pembuktian Perdata Dan UU No. 11 Tahun 2008 Tentang ITE", *Journal of Business Law* 29, no. 1 (2010), https://e-journal.uajy.ac.id/15988/1/Informasi%20Elektronik.pdf.

[15] Angga Priancha et al., "RETHINKING 'ELECTRONIC AGENT' TERMINOLOGY IN THE LAW ON ELECTRONIC INFORMATION AND TRANSACTION FROM THE PERSPECTIVE OF INDONESIAN LASTGEVING LAW," *Mimbar Hukum* 34, no. 2 (2022): 378–402, https://doi.org/10.22146/mh.v34i2.3864.

disseminate information. This concept is broader in scope than that of an Electronic System, as it encompasses the knowledge, methods, and technical means utilized in the management of information. Within the Indonesian legal regime, Information Technology is positioned as a foundational element of digital transformation, enabling the emergence of various forms of legal relationships within the electronic environment.

The conceptual distinctions between Electronic Information, Electronic Documents, Electronic Systems, and Information Technology demonstrate a hierarchical structure within the Indonesian Electronic Information and Transactions legal regime. Electronic Information operates at the level of data substance, Electronic Documents at the level of data representation, Electronic Systems at the level of data processing infrastructure, and Information Technology at the broader level of technological concepts and tools. This differentiation is significant, as each term carries distinct legal consequences when applied to the juridical classification of emerging technologies. This conceptual framework serves as a starting point for assessing whether quantum computing should be more appropriately understood as a form of Information Technology constituting part of an Electronic System, or whether it exhibits characteristics that transcend the established categories within Indonesia's electronic information and transactions legal regime.

2. The Judicial Elements of Quantum Computing as Electronic Information, Electronic Documents, Electronic Systems, or Information Technology Under the Electronic Information and Transactions Law

Within the framework of the Electronic Information and Transactions Law, quantum computing is not positioned as an independent legal category. The Indonesian Electronic Information and Transactions legal structure adopts a classification system based on the functional characteristics of technology, rather than on the emergence of specific technological developments.[16] This approach requires that each new technology be situated within the existing legal framework, provided that it satisfies the relevant statutory elements. Accordingly, the assessment of quantum computing is conducted through an examination of the elements already established within the Electronic Information and Transactions legal regime, particularly those relating to Electronic Information, Electronic Documents, Electronic Systems, and Information Technology.

The Electronic Information and Transactions Law adopts an inclusive conceptual approach toward technological developments. Any new technology related to electronic data processing tends to be subsumed under existing legal categories. This framework enables the law to remain relevant without necessitating the constant establishment of new legal regimes in response to technological innovation. Quantum computing is understood as a technology operating at the level of information processing, rather than as an informational object itself. This

[16] Atikah Mardhiya Rohmy et al., "UU ITE Dalam Perspektif Perkembangan Teknologi Informasi dan Komunikasi," *Dakwatuna: Jurnal Dakwah dan Komunikasi Islam* 7, no. 2 (2021): 309–39, https://doi.org/10.54471/dakwatuna.v7i2.1202.

characterization renders the analysis of juridical elements the principal instrument for determining its legal classification.

The first examination is directed at determining whether quantum computing may be regarded as Electronic Information. Under Article 1(1) of the Electronic Information and Transactions Law, Electronic Information is defined as a collection of electronic data that possesses meaning or is capable of being understood. This provision affirms that information must take the form of data that is subject to interpretation. Quantum computing does not satisfy this characteristic, as it does not present meaningful data per se, but rather functions as a method or mechanism for data processing. Accordingly, quantum computing is more appropriately classified as a technological instrument rather than as information itself.

In this context, quantum computing cannot be understood as Electronic Information due to its lack of representational character. Electronic Information is inherently associated with data that is capable of interpretation, such as text, sound, or digital symbols.[17] This characteristic demonstrates that information always contains a dimension of meaning that can be read or comprehended. Quantum computing, by contrast, operates to process such forms of data through the principles of quantum mechanics. While its outputs may constitute Electronic Information, the quantum computing system itself does not fall within this category.

The second examination assesses whether quantum computing may be classified as an Electronic Document. The Electronic Information and Transactions Law defines an Electronic Document as a form of Electronic Information that is created, transmitted, or stored through an Electronic System. This provision affirms that an Electronic Document always refers to the final form of digital information that is capable of being subsequently accessed or retrieved. An Electronic Document is inherently attached to the output of a systematically recorded digital process. Quantum computing does not satisfy this element, as it does not function as a medium for storing or representing information, but rather as a computational machine that generates outputs.

The outputs of quantum computing may take the form of Electronic Documents, including simulation results, encryption outputs, or data generated from quantum algorithms. However, such a relationship is merely derivative in nature, as Electronic Documents emerge solely as a consequence of the computational process. This indicates that the existence of an Electronic Document is not inherent in the computing system itself, but rather is attached to the output produced by such a system. Accordingly, quantum computing cannot be directly classified as an Electronic Document, as it does not perform the documentary function itself.

The third examination is directed at the concept of an Electronic System. Article 1(5) of the Electronic Information and Transactions Law defines an Electronic System as a series of electronic devices and procedures that function to process Electronic Information.[18] These elements encompass hardware, software, and interrelated operational procedures that are integrated with one another. Quantum computing satisfies these elements, as it consists of hardware components (such as qubit processors), algorithmic software, and interconnected

[17] Maskun, *Kejahatan Siber (Cyber Crime): Suatu Pengantar* (Jakarta: Kencana (Prenada Media Group), 2013). hlm 48-50

[18] Republic of Indonesia, Article 1 number 5, Law Number 11 of 2008 Concerning Electronic Information and Transactions

operational procedures. This structure demonstrates the existence of an integrated system for information processing.

Quantum computing, whether based on superconducting qubits or trapped ions, continues to meet the criteria of a system that processes electronic data. The primary distinction lies in the underlying physical principles employed, rather than in its functional structure as a system.[19] In other words, although its mechanisms differ from classical computers, its fundamental function remains within the scope of electronic information processing. Accordingly, quantum computing services delivered through cloud computing platforms, such as IBM Quantum[20] or similar platforms, may be understood as falling within the category of Electronic Systems under the Electronic Information and Transactions Law.

The legal consequence of classifying quantum computing as an Electronic System is the obligation imposed on service providers to comply with the regulatory regime governing Electronic System Operators. Such obligations include system registration, the implementation of security measures, and the protection of user data processed through the system.[21] The Electronic Information and Transactions Law does not differentiate between levels of technological complexity in establishing the baseline obligations for Electronic System Operators. Therefore, quantum computing remains subject to the same legal supervisory framework as other electronic systems.

The fourth examination is focused on the concept of Information Technology. The Electronic Information and Transactions Law defines Information Technology as techniques for collecting, storing, processing, and disseminating information.[22] This definition is broader in scope compared to that of an Electronic System, as it encompasses the methods and technological approaches employed in information management. Quantum computing conceptually falls within this category, as it constitutes an advanced method of information processing based on quantum mechanical principles that extend the capabilities of classical computation. This process positions quantum computing as part of the evolution of Information Technology.

As a form of Information Technology, quantum computing operates at an abstract methodological and scientific level. It encompasses the development of algorithms such as Shor's and Grover's algorithms, which enable data processing at exponentially faster rates compared to classical systems.[23] Such capabilities indicate a paradigmatic shift in the manner in which information is processed and analyzed. In this context, quantum computing may be juridically classified as a form of development within Information Technology in its broader sense.

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[19] Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information: 10th Anniversary Edition*. (Cambridge: Cambridge University Press, 2010), p . 2-4

[20]IBM Quantum is a division of IBM technology which is a pioneer in open access computer quantum to the public through the cloud. Cloud Computing from IBM Quantum can accessible via https://quantum.cloud.ibm.com/

[21] OECD, *Digital Security Risk Management for Economic and Social Prosperity: OECD Recommendation and Companion Document* (OECD, 2015), https://doi.org/10.1787/9789264245471-en.

[22]Republic of Indonesia, Article 1 number 3, Law Number 11 of 2008 Concerning Electronic Information and Transactions

[23] John Preskill, "Quantum Computing in the NISQ Era and Beyond." *Quantum* 2 (August 2018): 79, https://doi.org/10.22331/q-2018-08-06-79 .

CONCLUSION

Based on the foregoing analysis, the legal regime governing electronic information and electronic transactions establishes a systematic conceptual framework for regulating electronic activities through the distinction between Electronic Information, Electronic Documents, Electronic Systems, and Information Technology. Each concept performs a distinct function and occupies a different legal position, ranging from the substantive content of data, the form through which data is represented, and the means by which data is processed, to the methods and technologies that support the overall management of information. This differentiation demonstrates that the electronic information and transactions legal regime is not solely concerned with the end product in the form of information being exchanged, but also encompasses the infrastructure and technologies that enable such processes to occur. Accordingly, a proper understanding of each category is essential for determining the legal status of emerging technologies, including quantum computing. Such an understanding ensures that the process of legal classification may be undertaken in a systematic manner, consistent with the particular characteristics and functions of the technology concerned.

The overall analysis demonstrates that quantum computing cannot be classified as either Electronic Information or an Electronic Document, as both categories require the existence of data or a representation of information, whereas quantum computing functions as a means of information processing. This distinction confirms that quantum computing operates at the level of a technological instrument rather than at the level of informational content or informational representation. Instead, quantum computing is most appropriately classified as an Electronic System while simultaneously constituting a component of Information Technology. The concept of an Electronic System captures its technical and operational characteristics, whereas the concept of Information Technology reflects its broader conceptual and methodological dimensions. Such classification illustrates that the Electronic Information and Transactions Law possesses sufficient normative flexibility to accommodate advanced technological developments without requiring the creation of new legal categories. Consequently, quantum computing may be comprehensively analyzed within the existing legal framework without altering the fundamental structure of the legal regime governing electronic information and electronic transactions.

REFERENCES

Atik, Jeffery, and Valentin Jeutner. “Quantum Computing and Computational Law.” *Law, Innovation and Technology* 13, no. 2 (2021): 302–24. https://doi.org/https://doi.org/10.1080/17579961.2021.1977216.

Edmon Makarim. *Pengantar Hukum Telematika: Suatu Kompilasi Kajian*. Raja Grafindo Persada, 2005.

Fitri, Sherly Nelsa. “Politik Hukum Pembentukan Cyber Law Undang-Undang Informasi dan Transaksi Elektronik di Indonesia.” *Jurnal Justisia : Jurnal Ilmu Hukum, Perundang-undangan dan Pranata Sosial* 7, No. 1 (2022): 104. https://doi.org/10.22373/justisia.v7i1.12719.

Ghazaleh, Shereen Abu, Hassan Sami Alabady, Inas Al-Khaldi, and Mohamad Azmi Masod Abu-Moghli. "Securing the Digital Future: A Proactive Legal Framework for Quantum Computing Challenges." *Journal of Cultural Analysis and Social Change*, December 30, 2025, 4843–50. https://doi.org/10.64753/jcasc.v11i1.4044.

Hidary, Jack D. *Quantum Computing: An Applied Approach*. Springer International Publishing, 2019. https://doi.org/10.1007/978-3-030-23922-0.

Ignasius Sumarsono Raharjo. "Informasi Elektronik Pada Transaksi Electronic-Commerce Dalam Hukum Pembuktian Perdata Dan UU No. 11 Tahun 2008 Tentang ITE." 2010. https://e-journal.uajy.ac.id/15988/1/Informasi%20Elektronik.pdf.

Lukoseviciene, Aurelija. "Regulating Quantum Computers: Insights into Early Patterns and Trends in Academic Regulatory Conversations on the 'Quantum Revolution.'" *Law, Innovation and Technology* 17, no. 1 (2025): 241–70. https://doi.org/10.1080/17579961.2025.2469350.

Maskun. *Kejahatan Siber (Cyber Crime): Suatu Pengantar*. Kencana (Prenada Media Group), 2013.

Mateo Aboy, Marcelo Corrales Compagnucci, and Timo Minssen. *Quantum Technology Governance I*. Springer Nature, 2026. https://doi.org/https://doi.org/10.1007/978-981-95-8371-3.

Michael A. Nielsen and Isaac L. Chuang,. *Quantum Computation and Quantum Information: 10th Anniversary Edition*. Cambridge University Press, 2010.

Mosca, Michele. "Cybersecurity in an Era with Quantum Computers: Will We Be Ready?" *IEEE Security & Privacy* 16, no. 5 (2018): 38–41. https://doi.org/10.1109/MSP.2018.3761723.

Muzakkir and Taufik Hidayat. "JURIDICAL REVIEW ARTICLE 27A OF LAW NUMBER 1 OF 2024 CONCERNING THE SECOND AMENDMENT TO LAW NUMBER 11 OF 2008 CONCERNING INFORMATION AND ELECTRONIC TRANSACTIONS." *Jurnal Hukum Samudra Keadilan* 19, no. 2 (2025): 238–49. https://doi.org/10.33059/jhsk.v19i2.10650.

OECD. *Digital Security Risk Management for Economic and Social Prosperity: OECD Recommendation and Companion Document*. OECD, 2015. https://doi.org/10.1787/9789264245471-en.

Preskill, John. "Quantum Computing in the NISQ Era and Beyond." *Quantum* 2 (August 2018): 79. https://doi.org/10.22331/q-2018-08-06-79.

Priancha, Angga, Ardia Khairunnisa, Tasya Caroline, and Gilang Sephia. "RETHINKING 'ELECTRONIC AGENT' TERMINOLOGY IN THE LAW ON ELECTRONIC INFORMATION AND TRANSACTION FROM THE PERSPECTIVE OF INDONESIAN LASTGEVING LAW." *Mimbar Hukum* 34, no. 2 (2022): 378–402. https://doi.org/10.22146/mh.v34i2.3864.

Rohmy, Atikah Mardhiya, Teguh Suratman, and Arini Indah Nihayaty. "UU ITE Dalam Perspektif Perkembangan Teknologi Informasi dan Komunikasi." *Dakwatuna: Jurnal Dakwah dan Komunikasi Islam* 7, no. 2 (2021): 309–39. https://doi.org/10.54471/dakwatuna.v7i2.1202.

Syahriar, Irman. "Revisi Undang-Undang Informasi Dan Transaksi Elektronik Dalam Dimensi Politik Hukum." *Jurnal Ilmu Hukum "THE JURIS"* 5, no. 1 (2018): 6–14. https://doi.org/https://doi.org/10.56301/juris.v5i1.183.

Tamrakar, Abha, and Rishabh Sharma. “Quantum Computing: A Comprehensive Review.” *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 10, no. 3 (2019): 1634–42. https://doi.org/10.61841/turcomat.v10i3.14623