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№ 8 (4) - 2024

АКТУАЛЬНЫЕ ПРОБЛЕМЫ СОЦИАЛЬНО-ГУМАНИТАРНЫХ НАУК

ACTUAL PROBLEMS OF HUMANITIES AND SOCIAL SCIENCES

ТОШКЕНТ-2024

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10.00.00 – FILOLOGIYA FANLARI

12.00.00 – YURIDIK FANLAR

13.00.00 – PEDAGOGIKA FANLARI

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LEGAL RELATIONS AND STAKEHOLDERS IN QUANTUM TECHNOLOGIES REGULATION: A COMPREHENSIVE ANALYSIS OF GOVERNANCE FRAMEWORKS

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Abstract. This study provides an in-depth examination of the regulatory landscape surrounding quantum technologies, focusing on the types of legal relations and stakeholders involved. It explores the subjects and objects of governance, rights and duties, compliance mechanisms, and the balance between oversight and innovation. The research aims to map the legal topology of this emergent field and provide insights for developing effective regulatory frameworks. The study employs a comprehensive literature review and analysis of existing regulatory approaches, highlighting the complex interplay between various actors in the quantum ecosystem and the challenges of governing exponential technologies.

Keywords: Quantum technology regulation, Legal relations, Stakeholder governance, Adaptive oversight, International cooperation, Ethical frameworks, Technological innovation, Cybersecurity.

KVANT TEXNOLOGIYALARINI TARTIBGA SOLISHDAGI HUQUQIY MUNOSABATLAR VA MANFAATDOR TOMONLAR: BOSHQARUV TIZIMLARINING KENG QAMROVLI TAHLILI

Abdihakimov Islombek
Toshkent davlat yuridik universiteti, Kiber huquq kafedrasi o‘qituvchisi

Annotatsiya. Ushbu tadqiqot kvant texnologiyalari atrofidagi tartibga soluvchi landshaftni chuqur o'rganishni ta'minlaydi, huquqiy munosabatlar turlari va manfaatdor tomonlarga e'tibor qaratadi. U boshqaruv sub'ektlari va ob'ektlari, huquq va burchlari, rioya qilish mexanizmlari, nazorat va innovatsiyalar o'rtasidagi muvozanatni o'rganadi. Tadqiqot ushbu paydo bo'lgan sohaning huquqiy topologiyasini xaritalash va samarali me'yoriy-huquqiy bazalarni ishlab chiqish uchun tushunchalarni taqdim etishga qaratilgan. Tadqiqotda keng qamrovli adabiyotlarni ko'rib chiqish va mavjud tartibga solish yondashuvlarini tahlil qilish, kvant ekotizimidagi turli aktyorlar o'rtasidagi murakkab o'zaro ta'sir va eksponent texnologiyalarni boshqarish muammolarini yoritadi.

Kalit so'zlar: Kvant texnologiyasini tartibga solish, Huquqiy munosabatlar, Manfaatdor tomonlarni boshqarish, Adaptiv nazorat, Xalqaro hamkorlik, Axloqiy asoslar, Texnologik innovatsiyalar, Kiberxavfsizlik.

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Introduction. Quantum technologies promise revolutionary capabilities across various sectors, including computing, cryptography, sensing, and imaging. However, these advancements also pose complex regulatory challenges that demand careful consideration [1]. As these technologies rapidly evolve, there is an urgent need to understand and define the legal and ethical frameworks that will govern their development and use.

The regulatory landscape for quantum technologies is multifaceted, involving a diverse array of stakeholders, each with distinct rights, duties, and interests. This study aims to examine the key aspects of quantum technology regulation, including:

1. The regulatory subjects and their roles in governance
2. The objects of quantum governance
3. The rights, duties, and interests of various stakeholders
4. The relationships and compliance mechanisms within the quantum ecosystem
5. Emerging regulatory approaches and entities
6. The role of jurisprudential interpretations in shaping oversight
7. The challenges and opportunities in developing international regulatory frameworks

By mapping this complex terrain, this research seeks to provide valuable insights for policymakers, industry leaders, and researchers working to develop effective and ethical governance structures for quantum technologies.

Methods: This study employed a comprehensive literature review and analysis of existing regulatory frameworks, policies, and industry practices related to quantum technologies. The research methodology included:

1. Systematic review of academic publications in fields such as quantum physics, law, ethics, and policy studies
2. Analysis of policy documents and regulatory frameworks from various national and international bodies
3. Examination of industry reports, white papers, and ethical guidelines
4. Review of legal texts and court decisions relevant to technology governance
5. Comparative analysis of regulatory approaches across different jurisdictions

The collected data was synthesized to identify key themes, patterns, and challenges in quantum technology regulation. This approach allowed for a holistic understanding of the current regulatory landscape and the identification of potential future directions for governance.

Results:

1. Regulatory Subjects

The study identified several key regulatory subjects in quantum governance:

a) States and intergovernmental bodies: These entities create binding laws and international agreements governing quantum technologies [2]. For example, the European Union has implemented directives protecting critical infrastructure related to quantum technologies [3].

b) State-designated regulators: National agencies tasked with implementing rules and codes specific to quantum technologies [3].

c) Industry associations: These groups promulgate voluntary governance frameworks and ethical codes for quantum technology development and use [4].

d) Independent oversight entities: Organizations such as auditors that verify claims and assess compliance with established norms [5].

While states remain the primary regulatory force with supreme coercive capacity [6], the study found that diverse social oversight mechanisms contribute to a more decentralized

governance structure [7]. This multi-stakeholder approach helps balance innovation with risk mitigation.

2. Objects of Quantum Governance

The regulatory frameworks govern various aspects of quantum technologies, including:

a) Hardware: Quantum computers, simulators, and sensors b) Knowledge artifacts: Research papers, algorithms, and technical specifications c) Human capital: Researchers, engineers, and other skilled professionals in the quantum field d) Ecosystem elements: Training programs, funding mechanisms, and collaborative networks [8]

The study also found that contracts, licenses, and codes of conduct play a crucial role in governing relationships within the quantum innovation ecosystem [9].

3. Rights, Duties, and Interests

The research revealed distinct rights and duties for different quantum subjects:

a) States: Have the power to legislate oversight rules, enforce compliance through various mechanisms (e.g., personnel vetting, technology controls, sanctions), and balance security concerns with the need for scientific inquiry and due process [11][12].

b) Industry associations: Govern members through voluntary ethical frameworks and codes of conduct [13].

c) Researchers: Retain qualified rights to open science and academic freedom, balanced against professional ethics and public trust considerations [15].

d) Auditors: Verify claims and assess compliance when contracted, though accountability for their methodologies remains limited [14].

The study noted that while quantum computers currently lack intrinsic rights, strict oversight is necessary to ensure alignment with human values, especially given the uncertainty surrounding the potential development of artificial general intelligence [16][17].

4. Relationships and Compliance

Quantum oversight combines hierarchical authority, contractual governance, and rights contention [18]. The research found that a balance between state regulation and industry self-governance is crucial for effective oversight. Key findings include:

a) National regulators control access to sensitive technologies, enforce personnel screening, and conduct compliance audits [18].

b) Standards co-developed by state security experts and companies help balance interests, as seen in export control designations [19] and vulnerability disclosure programs [20].

c) Algorithmic systems are increasingly used in oversight, but their use raises concerns about reduced human accountability and judgment [21].

The study emphasizes the need for integrating automation's speed with human wisdom to foster legitimacy in oversight processes.

5. Jurisprudential Interpretations

The research highlighted the importance of judicial interpretations in shaping quantum governance:

a) Courts have inferred expanded data protections as human rights, indicating that states may have positive duties to compel commercial encryption [22].

b) Constitutional courts have emphasized academic freedom and speech rights against state constraints on scientific progress, such as publication preclearance requirements or researcher vetting [23].

These judicial interpretations serve to moderate unfettered regulatory power and protect fundamental rights in the context of quantum technology governance.

6. New Entities and Approaches

The study identified emerging trends in quantum technology regulation:

a) Cloud-based quantum business models are transforming access oversight, moving towards radically transparent verification of claimed capabilities by trusted reviewers [24][25].

b) Responsible development of quantum natural language processing is becoming a focus of governance efforts to mitigate risks of disinformation and dual-use concerns [26].

c) Adaptive governance systems are being developed to anticipate and respond to rapid technological advancements and unforeseen vulnerabilities [28].

7. International Regulatory Frameworks

The research underscored the need for international cooperation in quantum technology regulation, given the global nature of quantum innovation [33]. Key findings include:

a) The potential for establishing novel international legal instruments, such as a multilateral Quantum Technology Convention, to define rights and responsibilities of states in aligning rapid innovation with human rights protections [34].

b) The importance of interim steps, such as bilateral Memoranda of Understanding between states collaborating on quantum projects, which incorporate human rights clauses or external ethical reviews.

c) The value of multi-stakeholder consultation bodies at regional levels to foster collaborative governance approaches.

Discussion: The findings of this study highlight the complex and multifaceted nature of quantum technology regulation. The research suggests that effective governance requires a delicate balance between strict oversight and the flexibility needed to foster innovation. Several key points emerge from the analysis:

1. Adaptive Governance: Given the rapid pace of quantum technology development, regulatory frameworks must be flexible and capable of evolving alongside technological advancements. Adaptive governance systems that continuously scan horizons for potential risks and opportunities are crucial [28].
2. Multi-stakeholder Approach: The involvement of diverse stakeholders, including governments, industry associations, researchers, and independent oversight entities, is essential for creating comprehensive and effective regulatory frameworks [7].
3. Balancing Innovation and Risk: Regulators face the challenge of mitigating potential risks associated with quantum technologies while not stifling beneficial innovation. This requires thoughtful review processes that balance security concerns with the need for scientific inquiry and technological progress [12].
4. Global Cooperation: The inherently global nature of quantum innovation necessitates international cooperation in developing regulatory frameworks. The potential for

a multilateral Quantum Technology Convention or similar international instruments should be explored further [34].

5. Ethical Considerations: As quantum technologies advance, ensuring alignment with human values and ethical principles becomes increasingly important. This includes considerations of privacy, security, and the potential societal impacts of these technologies [29].

6. Judicial Role: The study highlights the significant role that judicial interpretations play in shaping the governance landscape, particularly in areas where legislation may lag behind technological advancements [22][23].

7. Emerging Business Models: The rise of cloud-based quantum computing services presents new challenges for oversight and verification of capabilities, requiring novel approaches to regulation [24][25].

Limitations and Future Research: This study's limitations include the rapidly evolving nature of quantum technologies, which may outpace current regulatory frameworks. Additionally, the focus on literature and policy analysis may not fully capture the practical challenges of implementing quantum technology regulations.

Future research should focus on:

1. Empirical studies of the effectiveness of different regulatory approaches
2. Case studies of successful (and unsuccessful) quantum technology governance initiatives
3. The long-term impacts of quantum technologies on society, economy, and international relations
4. The potential role of artificial intelligence in quantum technology governance
5. Comparative analyses of quantum technology regulation across different cultural and political contexts

Conclusion. This comprehensive study of legal relations and stakeholders in quantum technologies regulation reveals a complex and rapidly evolving landscape. The findings emphasize the need for flexible, iterative regulatory models that can adapt to the deep complexity and uncertainty inherent in quantum innovation.

Effective governance of quantum technologies will require a holistic integration of social and physical sciences, ethical considerations, and technical expertise. As these technologies continue to advance, it is crucial to develop governance structures that protect human dignity and fundamental rights while fostering responsible innovation.

The quantum revolution offers unprecedented opportunities for scientific and technological progress. However, realizing its full potential while mitigating risks demands not only groundbreaking science but also wisdom in constructing institutions and regulatory frameworks. By fostering collaborative, adaptive, and ethically grounded governance approaches, we can work towards a future where quantum technologies serve to elevate human consciousness and contribute positively to global society.

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