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Research Article

Journal of Standardisation

‘Scale Quantum, not bureaucracy’: Policy logics and geopolitical anxieties in the standardization of quantum technologies

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Abstract: The emerging ‘quantum era’ is often framed in terms of technological revolution and geopolitical competition. This paper offers a more grounded account of the development of quantum technologies by examining their formal standardization processes. Focusing on two key institutional sites—CEN-CENELEC JTC 22 and IEC/ISO JTC 3—we analyze how actors negotiate and stabilize meanings, priorities, and responsibilities in this early and uncertain technological field. Drawing on the theoretical framework of policy logics, we identify three dynamics that shape quantum standardization: (1) technological uncertainty and the premature timing of standardization complicate institutional coordination and national strategy; (2) conflicting policy logics are fused to ‘infrastructure’ an institutional formation that acquires autonomy over time; and (3) formal standards processes serve as a pressure valve for geopolitical tensions surrounding global technological trajectories. The analysis builds on a year-long ethnography of standardization meetings and plenaries, complemented by 9 elite interviews. By bridging insights from science and technology studies, institutional theory, and international political economy, the paper demonstrates how standardization institutions mediate the governance and global politics of emerging technologies.

Keywords: quantum technologies, standardization, policy logics, global governance, technology governance, geopolitics

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Submitted: 16-11-2025
Revised: 02-03-2026
Accepted: 07-07-2026
Published: 07-08-2026
Peer review: double blind

DOI:
https://doi.org/10.59490/jos.2026.8497

ISSN: 2772-9249

How to cite: Terzis, P., ten Oever, N., & van Hoboken, J. (2026). 'Scale quantum, not bureaucracy': Policy logics and geopolitical anxieties in the standardization of quantum technologies. *Journal of Standardisation, 5*. https://doi.org/10.59490/jos.2026.8497

Highlights:

1. Organizations are developing standards for quantum technologies, but uncertainty around the technology makes coordination and progress challenging.
2. Most participants are motivated by state funding and geopolitical anxieties, rather than clear market demand or commercial opportunity.
3. Stakeholders such as standards setters, scientists, and tech companies join for varied reasons; some are interested in science and innovation, while others respond to state support, hype, or funding drivers.
4. Commercial impact from quantum standardization remains limited, and the field’s direction is still uncertain, reflecting both institutional reflex and unresolved risks.
5. Quantum standardization is a uniquely bizarre space, where complex science meets the straitjacket of standards to (re)produce institutional forms that (pre)shape technological trajectories.

1 Introduction

On July 2 2025, the European Commission launched the 'Quantum Europe' strategy in an attempt to harness the 'ongoing quantum revolution'; a strategy that will be followed by a Quantum Act, expected to be proposed in 2026 after its consultation ended in late 2025; a month before the Commission's launch, the leaders of G7 published a statement acknowledging the 'potential of quantum technologies to bring transformative benefits to societies worldwide' (G7, 2025*)*; few months earlier, the OECD published a policy primer acknowledging quantum technologies as a 'new paradigm' for digital economies and societies (OECD, 2025). After all, the year 2025 was one that the United Nations and UNESCO had proclaimed as the International Year of Quantum Science and Technology.

Common thread amongst all these policy initiatives and narratives is a call for the creation of governance frameworks, public-private partnerships, and global synergies for the development of quantum technologies. And thus began the standardization of quantum technologies; a socio-technical enterprise where technical standards, geopolitics, and science collide to create an idiosyncratic institutional blend that previous work on standardization and international cooperation may find difficult to interpret and analyze not least because of the nascent level of technology, the lack of plausibly valuable use cases, and the complicated science involved. For this reason, this paper is an attempt, the first of its kind, to empirically map this new terrain and explore whether the wonder of standardization, this consensus-driven institutional formation of market competitors and national 'rivals', can indeed happen at a time of global disordering and geopolitical anxieties over a set of novel -and mysterious- technologies (Lang, 2024; McKeil, 2021).The standardization of quantum technologies started as a collaboration of two European Standards Developing Organizations (SDOs), namely CEN and CENELEC, that made the CEN-CENELEC FG on Quantum Technologies, predecessor to the currently running CEN-CENELEC JTC 22. This Joint Technical Committee (JTC) had been leading standardization for a couple of years until the international SDO IEC/ISO JTC 3 further internationalized these efforts. One year in, and China, the US, the UK, EU countries and others are working through the standards development process to get consensus on standards for quantum technologies which, however, are still in an experimental phase of their development.

Through active participation in and observation of the workings of the abovementioned SDOs as well as interviews with key stakeholders, we map the standardization landscape for quantum technologies and provide an overview of its underlying logics, dynamics, and future trajectories. This empirical exploration of the field of quantum standardization is contextualized within a theoretical framework that brings together lessons and insights from the study of institutions and the policy logics for international collaboration (Finnemore & Sikkink, 1998; Meyer & Rowan, 1977; Suzuki, 2017; Thornton et al., 2012b). In doing so, this project wishes to contribute to ongoing discussions about the role of international collaboration and institutional formation for technology governance (Marcovitch & Wilner, 2024; Musiani, 2015; Zúñiga et al., 2024).

The paper proceeds as follows. We first outline our methodological approach and situate the study within existing literature. We then engage in the analysis of policy logics per stakeholder group and country. Of all countries involved, we focus on the activity of China, the US, the UK, and Europe (as a bloc of countries). We conclude with theoretical reflections and discussion points for future research and policy debates.

2 Methodology

Given the complexity of the subject matter, some very fundamental background knowledge may help the reader better understand and contextualize our contribution. A common feature of the studied (quantum) technologies is that they seek to exploit the properties of physics on the scale of atoms and subatomic particles in order to provide novel information processing capabilities. In this paper, we adopt the classification most commonly used in literature and standardization practice by categorizing quantum technologies within three different sub-groups: quantum computing, quantum communications, and quantum sensing. Each one of these sub-groups comes with its own attributes, architectures, technical and epistemic challenges and as a result each sub-group requires a different pool of expertise as well as types and methods of knowledge (production). Throughout the paper, we maintain a wide angle with our focus locked onto 'quantum technologies' as the object of study, although the reader will also encounter (quantum) tech-specific analyses, particularly for quantum computing technologies and their related (standards) negotiations.

To map, comprehend, and analyze the policy and institutional logics at play we used a mix of qualitative methods. In doing so, we followed the rich scholarship from institutional analysis and organization studies that has highlighted the role and promise of such methods for understanding the institutional threading among cultural symbols, hegemonic norms, and material practices (Jones et al., 2013; Reay & Jones, 2016; Thornton et al., 2012b). Our analysis adopts an interpretivist and inductive approach that seeks to portray as much raw data as possible and canvas them creatively and interpretatively in an attempt to illuminate the particular phenomenon it seeks to analyze 'from the inside' (Denzin & Lincoln, 2017; Myers, 2009; Reay & Jones, 2016, p. 449). In this direction and in order to analyze our targeted SDOs (Table 1), we engaged in a detailed document analysis of the information made available by the formal standardization bodies, and in particular technical reports, national contributions to work items, and proposals for new work items. We then engaged in participatory observation to gain a deeper understanding of the processes and procedures, the culture of standardization, and to build a rapport among the community. We were able to access these rather formal and closed processes by the appointment of the first author as delegate of the Dutch national standardization body NEN (Nederlands Normalisatie-instituut) to CEN-CENELEC JTC 22 and the IEC/ISO JTC 3. Being part of the Action Line 4 of the Quantum Delta NL consortium offered a particular kind of research access to, and embeddedness with the object of study. In total, the first author attended 7 online meetings and 3 in-person plenaries in Turin, Italy and Malta, for CEN-CENELEC JTC 22, and in Seoul, South Korea for IEC/ISO JTC 3.

Table 1: List of abbreviations

Numbering	Affiliation
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
WG	Working group
ahG	Ad hoc group
JTC	Joint Technical Committee
SDO	Standards Developing Organization
FG	Focus Group

Subsequently, we engaged in 9 elite interviews with actors active in the standardization efforts (Table 2) to triangulate and deepen our findings from the desk research and participant observation. We sampled initial potential interview candidates through purposive sampling (Guetterman, 2015; Hibberts et al., 2012). The interviews were transcribed by automated means whose output was subsequently corrected by a transcriber. The interviews were then thematically coded. The study received ethical approval by the Ethics Committee of the University of Amsterdam (FDR-231).

Table 2: List of Interviewees

Numbering	Affiliation
interviewee 1	Big Tech / Science expert
interviewee 2	Big Tech / Science expert
interviewee 3	Big Tech / Science expert
interviewee 4	Scientist
interviewee 5	Small Tech / Scientist
interviewee 6	Small Tech
interviewee 7	Scientist
interviewee 8	Standards setter
interviewee 9	Standards setter

3 Literature Review

With quantum technology captivating the minds of many, we sought to analyze the concrete institutional settings and collaborations that give shape to the praxis of the standardization of quantum technologies. Increasingly, standardization is understood as a modus to regulate technology, in part because politicians are expected to draft rules that are technologically neutral, and, in turn, because experts are expected to shape technologies that safeguard security, interoperability, and quality control in a globalized production landscape (Blind, 2025; Cancela-Outeda, 2024; Yates & Murphy, 2021). The standardization of quantum technologies is a relatively recent practice, a fact reflected in the still-limited and largely descriptive literature on the topic (Agarwal & Mohanta, 2023; Jenet, 2020; Pitwon & Lee, 2021; Van Deventer et al., 2022; Yang et al., 2023).

Recently, the field of standardization has attracted renewed attention from a governance perspective, as it increasingly shapes the regulation of technologies and information infrastructures as a tool for industrial policy. Examples of this are the integration of standardization in the European Union's AI Act (Cancela-Outeda, 2024; Hennessy & Mügge, 2025; Veale & Borgesius, 2021) as well as the increase of Chinese participation in the standardization of internet technologies (Lee et al., 2022; Nanni, 2022; Teleanu, 2021) and telecommunication technologies (Becker et al., 2024; Hong, 2017; Maxigas & ten Oever, 2023; Nanni, 2021). As this adds to the rise of geopolitical tensions that are reverberating in the field of standardization, it is important to explore the relation between standards, states, and markets in establishing technological trajectories for large technical systems and digital infrastructures, particularly in those areas where the market uncertainty is high and the available pathways of/for technological development are multiple (Blind, 2025; Blind et al., 2017; Lambach & Monsees, 2025; Paris, 2021; Sovacool et al., 2018).

At the same time, in an attempt to deepen our understanding on the role of state actors in technological development, scholarship has highlighted the significance of institutional configurations and innovation intermediaries therein (Colovic et al., 2025; Lee et al., 2018). To dissect the tensions between standards, states, and markets we build on the framework of policy logics as developed by Suzuki (Suzuki, 2017). Policy logic analysis brings forward the 'logics that actors may follow for defining their long-term interests and goals, their policy conduct and behavior, and a set of values which would provide criteria for judging policy performance' (Suzuki, 2017, p. 7). It does so by centering attention on the 'reasoning conducted according to a system of policy principles in which experts, groups of stakeholders and decision-makers are committed to realize their respective objectives' (Suzuki, 2017, p. 22). Therefore, policy logics and institutional logics analysis (can) become theoretically and methodologically interwoven (Finnemore & Sikkink, 1998; Nielsen et al., 1995). For the purposes of the present study, and in order to understand the interactive processes of/for institutions-making between central decision-makers and experts, we draw parallels from, and extrapolate Suzuki's study on European space collaboration to the international arena of quantum standardization and use the toolkit of policy logics and institutional analysis to understand the dynamics of international cooperation in the nascent field of quantum technologies.

Suzuki's framework is particularly helpful in this study for three reasons. Firstly, a policy logics framework moves beyond simplistic neorealist perspectives on state collaboration and provides a richer account to analyze states' cooperation by fleshing out the dynamics of institutional development and the long-term visions of the diverse actors operating therein (i.e. national actors as well as 'experts'). Secondly, similar to the 'European' history of space collaboration that has been analyzed within the international context of international space collaboration and with reference to the strive for European autonomy, quantum standardization has had its own European history and 'players' before being brought to the international arena where policy and institutional logics change considerably. For instance, a logic of supporting European industry actors and the innovation ecosystems of the continent gives its space to an associated but distinct logic of leveraging specialization in global supply chains when brought in front of an international standardization audience. Thirdly, policy logics analysis allows us to move beyond declaratory narratives (i.e. national security or strategic autonomy) and anatomize how these narratives actually materialize in policy practice.

4 Findings

There are two significant variables for the motivations of the participants in quantum standardization: their professional stakeholder groups and their nationality or geographical region. Below, we first give an introduction into the field of quantum standardization; we then proceed to an overview of the policy logics per stakeholder group; and finally, we provide an overview of the drivers per significantly represented nation or geographical region.

4.1 Locating the field of quantum standardization

The European and global landscape for the standardization of quantum technologies was not built in a day. Different standards organizations such as the ETSI ISG-QKD and ITU-T SG 13 were already deep in the process of standardizing aspects of, and vocabularies for particular quantum technologies as early as 2008. Their work continues to this day with occasional liaison exchanges and progress updates between them as well as with the more recent actors described below. Meanwhile, the National Institute of Standards and Technology (NIST) has established standardization projects for post-quantum cryptography since 2016 aiming at developing encryption schemes that will be secure against potential attacks by quantum computers[1].

[1] Post-quantum cryptography, or PQC, is not considered a 'quantum technology' in its traditional sense. Indeed, PQC is not a quantum technology itself but a measure against possible quantum computers. PQC is about finding new information security measures on classical networks and computing systems that are vulnerable to attacks by quantum computers (specifically, overcoming the threat to a classical computer posed by a quantum computer capable of running Shor's algorithm). That said, it is not uncommon for policy and governance

European SDOs have arguably been the first ones to launch a holistic institutional initiative for the standardization of quantum technologies. In June 2020 CEN and CENELEC jointly launched the CEN-CENELEC Focus Group on Quantum Technologies (CEN-CENELEC FGQT) whose roadmap document represents the most comprehensive description of the developments in quantum standardization written to this day. The group was later transformed to the CEN-CENELEC JTC 22 (co-chaired by the Netherlands and Germany), which remains the central pillar for the European standardization of quantum technologies and one of the two main objects of the present study.

The international landscape was slightly slower to develop. By absorbing the functioning and work items of the IEC/ISO JTC 1 WG14, a working group that had been established under the umbrella of IEC/ISO JTC 1 on 'Information Technologies' in 2020, IEC/ISO JTC 3 kicked off in May 2024 and currently represents the central pillar for the international standardization of quantum technologies; in other words, the 'international equivalent' of the CEN-CENELEC JTC 22. As will be discussed further below (section 4.2.5), the relationship between the European and the International standardization was and still is a complicated one.

In terms of structure, the two major standardization initiatives have classified the various applications of quantum technologies into three different segments (i.e., quantum communications, quantum sensing, and quantum computing). CEN-CENELEC JTC 22 and IEC/ISO JTC 3 have created standardization sub-groups that broadly mirror this classification. Tables 3 and 4 illustrate the thematic structure of these organizations and their associated workflows.

Table 3: CEN-CENELEC JTC 22

WG1 - Strategic Advisory Group
WG2 - Quantum Metrology, Sensing and Enhanced Imaging, and Quantum Enabling Technologies
WG3 - Quantum Computing and Simulation
WG4 - Quantum Communication and Quantum Cryptography

Table 4: IEC/ISO JTC 3

AG1 - Strategic planning
AG2 - Chair's Advisory Group
ahG3 - Quantum Sensors (Sensing, Devices, and Imaging)
ahG4 - Quantum Communication
ahG5 - Quantum Computing and simulation
ahG6 - Quantum Random Number Generator (QRNG)
ahG7 - Quantum enabling technologies

4.2 Policy logics of stakeholder and power blocs

Stakeholders engage with the standardization of quantum technologies for different reasons (Table 5). In our analysis, we were able to identify different stakeholder groups with varying interests that informed their participation in the standard setting process. Professional standards setters, scientists, small and medium enterprise entrepreneurs, and Big Tech company staff, all bring their own incentives and agendas, while at the same time managing to give 'life' to a kind

initiatives to 'subsume' PQC under their 'quantum' agenda as the development of PQC does require advanced knowledge of what is possible with quantum technologies and quantum algorithms in particular.

of self-preserving institutional impetus of/for international collaboration whose nature is exceptionally difficult to comprehend and navigate.

Contrary to past examples of standardization, our study did not encounter 'lone' or independent standard setters, in other words, individuals involved in the standardization process out of a genuine interest in the subject matter or because of social networks whose bottom-up dynamics have mobilized participation in standard-setting in the past (Henrich-Franke, 2008; Isaak, 2006; Jakobs, 2000; Zi & Blind, 2015). If anything, on a number of occasions, standard setters have repeatedly highlighted the institutional need to spread the message of quantum standardization to persuade more people to get involved. However, the specialized nature of quantum technology, the high cost of quantum lab setups, and the securitized nature of the technology might hamper the participation of independent standard setters.

Building on the above, this section sets out to map the different logics of the actors involved before analyzing the themes they share and the stories they tell.

4.2.1 Standard setters

Standards setters in quantum standardization do not necessarily have a STEM background but share an extensive experience in the development of standards in the neighboring fields of telecommunications and information technologies. They are those who drive the standardization process forward and provide the bureaucratic channels through which the *praxis* of standardization flows. As one such expert put it: '[we] know rules, and we just follow the directives'. This traditionally bureaucratic role of standards setters is linked and attached to the standards organization whose mission they promote. Their role can be quite significant, particularly at the early days of standardization. For example, during the kick-off meeting of the IEC/ISO JTC 3 in Seoul, the interventions of the ISO representative were instrumental in defusing tensions about the structure of the new SDO by suggesting the creation of ad hoc Groups (ahG) to temporarily work on particular aspects of standardization. Interestingly, with regard to expert representation, the vast majority of the participants in the IEC/ISO JTC 3 kick-off meeting were standard setters. As interviewee 8 put it: 'I haven't monitored that many quantum related experts [at the IEC/ISO JTC 3 first plenary]. I have seen several old friends, [but] we are not quantum'.

Getting the vocabulary right

Much of the CEN-CENELEC JTC 22 work and progress has gone into building commonly agreed vocabulary, terminology, and metrics for the industry. Experts are developing descriptions and functional requirements for things such as modules for cryogenic solid-state quantum computing; metrics and terminology for quantum technologies; parameters and methods for traveling-wave parametric amplifiers; a layer model of a quantum computer (or a universal gate-based quantum computer); and benchmarks for quantum computing. Internationally, the focus is similar but less advanced. In particular, at the time of writing the IEC/ISO JTC 3 has two active projects; one on building vocabulary for quantum photonics and an introductory standard on terminology for quantum computing (a work item that it inherited from IEC/ISO JTC 1 WG14) (IEC/ISO, 2024).

Standard Setters' Policy Logic: 'This is what we do'

Standards experts are involved in standardization of quantum technologies, broadly, for two reasons. Firstly, there seems to be some policy and institutional demand for it. Various national 'quantum initiatives' around the world make explicit reference to the need for standardization (UK National Quantum Technologies Programme, 2015). Secondly, and relatedly, there is ample funding that is driven by the states' anxiety to win the 'quantum race' (Candelon et al., 2022; The Guardian, 2017). As one standard setter observed:

‘Things are getting even more interesting in quantum, because there's also this crazy government funding [...] and I can only qualify it as crazy, because this is something unlike anything I've ever seen before in my life’.

In a similar spirit, interviewee 1 observed: ‘I think the reason for this outsized focus on the industry despite the early stage of the technology is almost 100% the geopolitical interest in the predicted ability to break Shor's algorithm’[2]. Getting access to such funding is easier if you are part of the community. In at least two cases, standards setters were notified via mailing lists about ongoing small- and medium-size funding opportunities that explicitly required ‘minimal effort for preparation’ (~1 hr and ~1000 words).

This policy and funding frenzy for the development of standards for quantum technologies often clashes with the nascent level of the technology at hand. Admittedly, standard setters know that they are here early. This theme is common especially across quantum computing experts and scientists. ‘The question is’ interviewee 5 noted ‘how far you can standardize something that is still in an early phase of development and maturity […] you cannot go faster than light’. Highlighting the contradiction between the stage of technology demand and the institutional demand to produce standards, interviewee 4 noted: ‘There is a challenge in trying to make even the technical report too rigid and too detailed and I think that will be completely irrelevant in even just one year from now’. According to interviewee 2, the process was premature:

‘Important standards are important when we have products that can actually solve problems I can’t do classically. This is 5 to 10 years out, it’s premature […] How about we start standardizing time travel? We need standards for time travel. We need ethics for time travel.’

When it comes to quantum communications some interviewees were more cynical. One interviewee in particular noted:

‘If you are a sociologist, I would recommend you to follow the ‘Quantum Key Distribution (QKD) race’, because it's a crazy market with crazy market drivers and I think it will be a very good input for a book in 2030: how could ‘beep-beep’ (resembling ‘censor beep’ sound effect) have been that wrong and everybody knew it?’

Scientists and standards setters are generally ambivalent (to put it mildly) as to the prospect of QKD; a sentiment that was also evident in one of the social activities organized as part of a CEN-CENELEC JTC 22 plenary session. During a tour to what was advertised as QKD infrastructure that was also attended by a government official of the hosting country, the participants were taken through a large room full of racks of humming classical servers. Towards the end of the tour, the participants were led to a corner rack where only one small box was stacked; the ‘QKD system’. Following the guide’s description of its functionality, some participants were in such disbelief to the technology’s promise and potential that they felt the need to go behind the rack and see for themselves that the box was actually connected to power and cabled through to the rest of the infrastructure. ‘Where does this cable go?’ thus kicked off a nice on-the-ground exploration of hyped expectations and technology affordances.

[2] Shor’s algorithm is a quantum algorithm to find the prime factors of large numbers in polynomial time. Given the potential of a quantum computer offering exponential speed up, one of the most celebrated applications for the technology has been its proclaimed ability to break public-key cryptography. That is, given enough number of qubits and minimization of their noise (or errors), a quantum computer can compute in ways that have not been feasible for classical computers. Therefore, mainstream encryption schemes that are widely used today and have been designed based on the capabilities of classical computers in relation to the factoring of large numbers are exposed to risk. For this reason, organizations are working towards the development of the so-called post-quantum encryption standards that would also be safe against attackers with a quantum computer.

Finally, nowhere else is the discussion over the timing of standardization more revealing than in the negotiations over the standardization of the architecture of a quantum computer, which has been one of the central discussion points of the CEN-CENELEC JTC 22 WG3. Standardizing on paper what a quantum computer can and/or will look like was (and still is) a constant intellectual and scientific challenge for the experts in the room. It manifests the different incentives and logics of the standard setters who see the potential for market-creation in each layer agreed and standardized, and the scientists/small tech who still try to figure out how a quantum computer might be scientifically envisioned and materially architected (see below). But it is a process that, overall, everyone involved seems to enjoy. In fact, they enjoy it so much that in some cases, they will follow their official deliberations in the working group with 'working dinners' to keep discussing 'the layer model'. As a result, in October 2025, the 'Layer Model of Quantum Computing' became the first Technical Report adopted by CEN-CENELEC JTC 22 (CEN-CENELEC, 2025); its first ever deliverable.

4.2.2 Scientists

Due to the complex nature of the technology, quantum standardization also involves scientists. These are usually PhD-educated individuals, and their scientific background varies significantly illustrating the vast range of expertise that is pooled into the standardization process. They can be material scientists, mechanical engineers, electrical engineers, fabrication experts, technicians, quantum information theory experts, experimental physicists and others. They do not tend to have prior experience in standardization and most of them are either part of a consortium or university's research group. For example, participants of CEN-CENELEC JTC 22 WG2 come from similar scientific agencies such as national physics laboratories and metrology institutes. For other applications, such as quantum computing, technology-specific and interdisciplinary challenges exacerbate problems with the required expertise. For instance, the decision to design and/or standardize a superconducting, photonic-based or trapped-ion quantum computer will ultimately determine the kind of scientific expertise that you will need to bring to the table. As interviewee 5 noted: 'If you find someone that is telling you I'm an expert in everything in quantum computing [laughs] you know that it's not someone that is reliable'. Adding 'computation' to the required mix of expertise can complicate things further. As interviewee 2 noted: '[T]he key problem [...] is that there are many people who are quantum experts. They come from quantum information theory or from experiments in physics. They have no background in classical computing. And that then leads to many statements and claims and misconceptions. They take a while to debunk'.

From the lab to the market

Despite their presence and activity, it easily becomes obvious that the standardization landscape is not the quantum scientists' natural environment. 'As a scientist, [standardization] is really learning by doing. And I have the feeling that sometimes we [...] ask silly questions and do not obey, you know, the rules and structures that are there for a long time', interviewee 7 added. For this reason, the co-existence of the scientific and the standard expert can be described as 'necessary', 'complementary', 'challenging' and anything in between this spectrum. In the early days of the standardization work on the 'layer model' one could almost feel the tension in the room between those who wanted to 'brainstorm' (scientists) and those who wanted to 'standardise' (standard setters). 'You can make programmes and roadmaps for everything, but if you don't have the people to work in them…' a quantum scientist said to reflect the difficulties they encounter in bridging the logics between the two groups with another observing that 'when I try to invite more experts to join, they all see the value. [...] But then when they see how slow and time consuming it is, they cannot convince their executive that they can spend time and money on that'.

Scientists' Policy Logic

Scientists are primarily involved in standardization due to a genuine institutional demand for it. 'For quantum, certainly it's true that this closeness to research is something that will stay there for several years, and therefore it also totally makes sense that you have scientists [...] in a standardization committee, which otherwise would maybe not make sense' (interviewee 7). To that end, personal and professional networks had been critical in forming the initial bonds between the world of standards and that of science.

This institutional demand as a driver for the scientists' participation is often backed by an authentic belief in the science underpinning the development of quantum technologies. 'For some people [quantum] feels like magic and from my point of view the contrary is true. It's like a theory that is 100 years old. It gives us the best predictions we have ever gotten and there's not a single experiment that contradicts it' interviewee 7 added. Getting involved in standardization has given these scientists not only a venue to test and promote their scientific work but also access to a community of scientists and researchers from around Europe and the world with similar interests and ideas that are bound together by the challenge of generating impact by creating science-backed solutions that commercial users will find useful.

4.2.3 Small and Medium Tech Enterprises

The 'small tech' involved in the development of quantum technologies can be broadly divided into two sub-categories. We call the first the 'science entrepreneurs': a particular sub-group of scientists who have founded a quantum-related start-up and engage in quantum standardization in this capacity. Science entrepreneurs are, admittedly, far better represented in CEN-CENELEC JTC 22 than they are in IEC/ISO JTC 3. Their strong scientific background coupled with their technology-, or component-specific focus differentiates them from the second category, the 'venture capital entrepreneurs'. These are start-ups that, fueled by hype, generate revenue by pitching and promising quantum solutions to potential clients. Often, clients will approach these start-ups wanting to develop 'something quantum' for their portfolio. Such start-ups are rarely in the standardization discussions but came up during our study as a common discussion point amongst the various stakeholders. A good example of such start-ups are, according to interviewee 2, those that promise quantum computing applications for finance. This is because a quantum computer could only be useful for a very narrow set of problems that require exponential compute and little data; an affordance that makes any application that 'loads' data (i.e. 'big data' applications) impossible to accommodate. Interviewee 2 was once again quite clear: 'when I asked [a venture capital entrepreneur]: 'Why are you selling your quantum software to finance companies?' the answer was 'Because they have money'.

SMEs' Policy Logic: building a market and banking on the hype

Science entrepreneurs, particularly from the European quantum ecosystem, are naturally incentivized to engage with standardization to ensure that their interests will be included into the relevant standards. For this reason, some of them have been leading the standards development in their particular area of expertise (e.g., quantum computing benchmarks) in CEN-CENELEC JTC 22. On the contrary, venture capital entrepreneurs are interested in the valuation of their start-ups. Their interests do not lie in securing interoperability of specific components and materials in a commercial use case for quantum technology, but rather in safeguarding the required competencies that will allow them to make plausible promises of quantum solutions. Hype is a key ingredient of their strategies. As interviewee 2 helpfully observes, 'hype' is not a by-product of the quantum ecosystem but one of its endemic conditions:

‘[T]he [venture capitalists] require a path to revenue in three years, and so [quantum start-ups] all have to claim that in three years they will build a noisy intermediate-scale quantum (NISQ) quantum computer with 50 noisy qubits that will solve amazing things. That's the wrong incentive. And if they don't say that, they'll not get the funding. So they're incentivized to hype it up. And if somebody wants to invest in quantum for finance, then of course. So, the funding here gives the wrong incentives.’

4.2.4 Big Tech

Despite their proclaimed and widely advertised quantum projects, Big Tech is not heavily involved in its standardization. In particular, there is no presence of Big Tech companies in CEN-CENELEC JTC 22 which is not entirely surprising given the European nature of the initiative, whereas in the IEC/ISO JTC 3 the US delegation involves experts who are, or have been employed by Big Tech companies. Their involvement and contributions, however, still remain modest. Importantly, those experts affiliated with Big Tech that are involved in quantum standardization usually come from the ‘standards arm’ of the company rather than the (quantum) scientific one, a strategy that is perhaps indicative of the (non-)prospect Big Tech sees in the project of quantum standardization overall. ‘We want to be very choiceful in how we use the time of the quantum experts’, one US delegate explained. Therefore, contrary to some European delegations, US technology companies in national delegations are usually represented by people with extensive experience in standardization rather than quantum researchers and/or scientists with an active agenda in building quantum-related products and solutions. This ‘dual agency’ also manifests some of the difficulties inherent in classifying participants in the standardization field prompting generative questions as to the complex incentives and logics that interplay not only vertically across stakeholders, but also horizontally.

What (Acts)

Despite their presence through their respective national delegations, scientists from Big Tech companies remain -at least at this stage- largely uninterested in the discussions about the standardization of quantum technologies. Commenting on CEN-CENELEC JTC 22 project for standardizing the layer model of a quantum computer, a research scientist from a Big Tech company was almost dismissive: ‘it makes lots of sense for smart people interested in quantum to think about the architecture of a quantum computer. [But we are] building them, we've done it already’. In the same spirit, interviewee 1 observed that ‘at a high level there is quite a strong feeling that [...] there are almost no areas for which we need actual technical standards at this point’. For these reasons, interviewees from Big Tech as well as US delegates with a Big Tech affiliation seemed more interested in and engaged with promoting standardization progress in ‘low-hanging fruits’ such as definitions and metrics.

Big Tech Policy Logic: Preference for de facto standards

Big Tech companies are in the enviable position of being the de facto infrastructure for all things digital. As interviewee 9 noted ‘[name of company] is not selling you quantum computers. They are selling quantum computing services. [another name of company] seems to have a similar thing where you're talking about cloud quantum computing. And actually the only thing that you need to address their computer, is an API’. This can also explain why an interviewee from the research arm of a Big Tech company seemed extremely skeptical about quantum computing standardization in general:

‘Is the activity of thinking about quantum computing [...] then useful? Yes, totally. Is it exciting, fascinating? Totally. Does it help people learn about quantum computing and shape their minds? Totally. Do we need an ISO standard? On quantum architecture? No, it's too early and those people will not be the right people.’

4.2.5 Nations and Geographies

As much as support and funding for the early development stages of quantum technologies is state-driven, so is the case for quantum standardization. This section applies a horizontal classification across the identified stakeholder group above by incorporating their roles as national or regional representatives.

China

The Chinese delegation was and remains heavily involved in the standardization of quantum technologies, in general, and quantum computing, in particular, since its early days. China was leading the IEC/ISO JTC 1 WG14 (Quantum Computing) before it was transformed into the IEC/ISO JTC 3 and suggested a way forward to incorporate the former's projects and work items into the new organization. Despite the perplexity and administrative workload caused by this transition, China remained committed to the standardization project. In the workings of IEC/ISO JTC 3, the Chinese delegation has so far emphasized the need for developing roadmaps for standardization across the family of quantum technologies and presented concrete ideas for the standardization of atomic gravimeters, single-photon sources, optical clocks, and free-space quantum communication.

Why (Logic)

China has made standardization an inherent part of its industrial policy. This is reflected in the 'China Standards 2035' initiative that builds on the flagship 'Made in China 2025' technology strategy. Although China's role used to be that of a 'standard taker', its legacy and strategy for building and 'institutionalizing' telecommunication standards transformed China to a strong contender in global standardization. Hence, it was no surprise that the Chinese delegates in the first IEC/ISO JTC 3 were mostly standards experts with a long track record of standard setting in regional and international SDOs from the fields of telecommunications and information technologies. However, it is safe to say that China was left slightly off-balanced when the UK undertook the initiative to recommend the creation of the IEC/ISO JTC 3 and the 'absorption' of the then China-led IEC/ISO JTC 1 WG14 group therein. Coupled with that, with Australia leading the IEC/ISO AG 1 on 'Strategic Planning' and Australia-France leading the sought-after ahG 5 on 'Quantum Computing and Simulation', China no longer has a chair/convenor position at a 'strategic' ahG. However, China, following the country's policy in standardization in general, remains committed to, and quite enthusiastic about quantum standardization by investing in their scope and procedure.

United States

The US delegation is represented by government, academia, small businesses, and (standards experts from) Big Tech; a choice that as one interviewee explained is very deliberate in making sure that input from all stakeholders is reflected in the standardization process. The US approach is more ambivalent to standardization than that of the Chinese representatives. On the one hand, they actively participate in the proceedings and in populating important ad hoc groups. On the other hand, they warn against the risk of harming the potential of quantum technologies by standardizing them too early. 'Scale Quantum, not bureaucracy' was the motto of the US contribution at the second meeting of the IEC/ISO JTC 3 in Edinburgh; a motto that left many participants perplexed as to what the actual contribution to the standards process might be. 'I have seen that they didn't propose any specific project on this, but they have some point of view on how to run this new JTC' one interviewee observed.

Why (Logic)

Central to this US approach is a proclaimed focus on the end-user, one interviewee observed and added 'the purpose of standards, done properly, is not to create more standards and the end result of standards is not standardization in and of itself'. Thus, the US has consistently drawn participants' attention to the risks of the early standardization of quantum technologies. The culmination of this strategy and narrative is the US national standard institute (NIST)'s recent agenda for developing the 'Standardization Readiness Level' concept. The project was advertised in one of the CEN-CENELEC JTC 22 meetings (where the US has been invited as guest) as a tool to keep standardization neutral and science-based, rather than politicized, by prompting stakeholders to ask not if we can build a standard but whether we should indeed do so. Contrary to the rest of the delegations we observed and interviewed, the US seemed more reluctant to acknowledge the 'geopolitical' character of quantum standardization. 'If you don't have an industry, there is nothing to do [a geopolitical] analysis on' a US delegate observed. However, despite this reluctance and the US's enviable position in the political economy of technology production, the country observes and closely monitors the growing activity of China in the field of quantum standardization.

United Kingdom

The UK delegations in quantum standardization meetings are largely comprised of standards experts from the British Standards Institution (BSI) and scientists from the National Physical Laboratory (NPL). The latter usually share a background in quantum theory, photonics research, quantum sensing, classical computing, and cybersecurity. Private organizations and start-ups are largely absent.

Taking things to a higher level

BSI and the UK delegation more broadly have taken an active role in contributing to the work of WGs and ahGs in CEN-CENELEC JTC 22 and IEC/ISO JTC 3, respectively. The steady progress in the development of standards for common definitions and metrics for quantum technologies is largely a result of the UK's continuous work in CEN-CENELEC JTC 22 and IEC/ISO JTC 3. But alongside their active contribution in leading this agenda forward, the UK's role has been quite pivotal in further shaping the landscape of quantum standardization more broadly. In particular, the UK led the transformation of the IEC/ISO JTC 1 WG14 to the newly formed IEC/ISO JTC 3. It did so by making the case that quantum technologies are not just 'quantum information technologies' and as such they cannot fit under the umbrella of a joint committee on information technologies. As a kind of technology that will change the world deeply, the UK delegation argued to the IEC and ISO management boards, it would make sense to separate the project of quantum technologies standardization from the rest of information technologies and the work of IEC/ISO JTC 1. 'I have never met this kind of approach' a standard setter and national representative highlighted to describe the UK's position of 'advertising' the need for a new IEC/ISO JTC during the plenary session of the IEC/ISO JTC 1 and having the new organization 'absorb' all the work that was underway in the latter's WG14. Regardless, so it began the IEC/ISO JTC 3, the third joint committee in the history of IEC and ISO after the creation of JTC 1 on 'Information Technologies' in 1987, and that of JTC 2 on 'Energy Efficiency and Renewable Energy Sources' in 2009. Admittedly, it took some 'diplomacy' to get there. The UK was and still is part of the CEN-CENELEC JTC 22 and, as a result, it had to navigate its chosen path forward without challenging relationships with its European counterparts and/or being seen as compromising their interests. At the same time, the transition to the IEC/ISO JTC 3 would have to respect the boundaries with other standards committees and organizations and to do justice to the work that had been done in IEC/ISO JTC 1 WG14.

UK Policy Logic : Standardization as key part of National Industrial Policy

The UK presence in the regional and global standardization fora builds on, and reflects the country's strategy for seeking a leading role in the development of quantum technologies. The sentiment that quantum technologies will revolutionize markets and society was part of the UK's National Quantum Strategy before it became a diplomatic argument for the creation of the IEC/ISO JTC 3. Pushing the agenda for this creation seems to have been high on the list of priorities of the UK delegations. One way to interpret this desire is to contextualize it within the broader political agenda for claiming the country's stake in shaping the technologies of the future by leveraging the UK's knowledge resources and social skills in institutional entrepreneurship to stay in the orbit of decision-making processes and systems. 'It is not in the UK's interests to sit back and rely purely on others for access to quantum computing hardware' reads the country's National Quantum Strategy.

European Union and Member States

In Europe and the CEN-CENELEC JTC 22, participants in quantum standardization come from a variety of backgrounds. They are traditional standards experts, research scientists in universities, science entrepreneurs, civil servants in national scientific institutes and laboratories, and policy advisors. Some European delegations are clearly more active and influential. These include the Netherlands, France, Germany, and the UK. The European Commission is also represented therein as the main policy driver behind quantum standardization. In IEC/ISO JTC 3, participants from European countries are largely the same people who had also attended and contributed to the work of CEN-CENELEC JTC 22 over the last 4 years and they stand quite united as a bloc. A lunch prior to the kick-off session of the IEC/ISO JTC 3 in Seoul was widely attended and consolidated the feeling of having essentially 'one European actor' on the international stage of quantum standardization. 'I think the good thing is we have a certain level of consensus in Europe, which is very important', one interviewee noted.

First mover disadvantage

As mentioned above, European countries were the first to set out the groundwork for the standardization of quantum technologies by creating the CEN-CENELEC FGQT, the precursor of CEN-CENELEC JTC 22. Standardization work continues steadily therein with some WGs already working on publishing their first standards. However, the non-standard-setting acts of the European countries are equally significant to their project. As described above, towards the end of 2023, the standardization of quantum technologies was going global. And although a global effort to standardize quantum technologies perhaps makes sense from an industrial and supply chain point of view, EU delegations were slightly perplexed by the UK's position on the topic. 'This is news to me' was voiced at a CEN-CENELEC JTC 22 plenary meeting by a member of a leading European delegation when the UK announced that it will be leading the creation of the IEC/ISO JTC 3. This initial reaction was followed by a series of meetings and discussions on the ongoing relationship between the CEN-CENELEC JTC 22 and the IEC/ISO JTC 3 that continues to this day.

The concerns that the European stakeholders held and shared before the IEC/ISO JTC 3 kick-off did not take long to materialize. The first point of tension came when European delegations realized that the CEN-CENELEC 'input' to the first session of the IEC/ISO JTC 3 had been demoted to the 'Any other business' items of the agenda. This essentially meant that the co-chairs of the CEN-CENELEC JTC 22 would have taken the floor towards the end of the meeting by which point, they thought, most of the important matters would have already been raised and most of the participants would have been waiting their dinner after a very long day of negotiations. When European participants voiced their preference to introduce their work as a discussion item, they faced the gentle resistance of the US delegation, whose representatives argued that the CEN-CENELEC JTC 22 contribution is essentially a liaison statement which should be placed in the agenda accordingly. 'It's beyond a liaison statement' a leading European delegation responded. Judging from the reactions and the 'sighs' in the room, it is safe to say that the US stance was received as 'bizarre' and/or 'aggressive' (or anything in-between this spectrum) by European delegations. As interviewee 7 noted: '[..] in the end it is a political game'. The Europeans did get it their way, finally. They were now a proper agenda item.

Legal troubles

The relationship and exchanges between the CEN-CENELEC JTC 22 and the IEC/ISO JTC 3 became even more complicated for two purely legalistic and administrative reasons. Firstly, there is no legal framework for the cooperation of JTCs of the four standards organizations involved. To make matters more complicated, CEN has a cooperation agreement with ISO (the 'Vienna Agreement') and CENELEC has a cooperation agreement with IEC (the 'Frankfurt Agreement'), but, surprisingly, there is no legal framework for a CEN-CENELEC - IEC/ISO cooperation, a gap that the respective management boards are currently trying to resolve. This is not the first time that international and inter-organizational cooperation takes place. For instance, the IEC/ISO JTC 1 SC41 on 'Artificial Intelligence' cooperates in various ways with its European counterpart, the CEN-CENELEC JTC 21. But in the quantum standardization landscape, we observe for the first time such a clear overlap between the founding mission for standardization of the two JTCs involved.

Secondly, the Secretariat of the IEC/ISO JTC 3 postponed the European request for the establishment of a formal liaison relationship between CEN-CENELEC JTC 22 and IEC/ISO JTC 3, because CEN-CENELEC JTC 22 'is not an international organization'. Following up the initial rejection, the European Commission itself decided to issue a request for the formalization of a liaison relationship with IEC/ISO JTC 3.

EU Policy Logic: harmonization for a single market

Europe has a complex policy conundrum: European standards support the European Single Market, so the work by CEN-CENELEC could not be dropped. However, globalized standardization in ISO-IEC could prove to scale the influence of European standardization. There is a risk though that increasing the number of SDOs might lead to duplication of efforts and dilution of (an already scarce pool of quantum) expertise. Furthermore, European institutions, generally, and the European Commission, specifically, are worried that the standardization progress as well as the significant amount of money they have poured into the European quantum ecosystem risks becoming mere inputs to a geopolitically sensitive process of globalized standardization from which Europe will not directly benefit. Lacking the big technological behemoths and supply chain orchestrators of the US and China, European innovation in the field is pushed forward by the dozens of SMEs and start-ups that hope to capture and commercialize small aspects of the quantum technology market (such as the markets for wiring and cabling of cryogenics technologies) and to build their own regional supply chains. As a result, their interests might be harder to negotiate amidst a plethora of voices and consensus-driven processes in global standardization.

Table 5: Policy Logics and drivers in quantum standardization

Actor	Subgroups	Dominant Logics	Driver
Standard Setters	CEN-CENELEC, IEC/ISO	protocolized standardization	tool of the trade, professional identity, funding

Scientists	university staff, publicly employed scientists (such as at metrology institute), consultants for governments to inform standard-setting	facilitate and apply theoretical research	expertise, public interest
Small Tech	science entrepreneurs, venture capital entrepreneurs	compete in emerging markets, profit	scaling opportunity, venture capital
Big Tech	standards staff, science staff	de facto standards, competition	stay informed of competitors' developments, ensure their development is not limited
Country: China	Standards Setters, Scientists	controlling technology development	de jure standardization and market coordination
Country: US	Standards Setters, Big Tech, Scientists	scaling US markets, resisting bureaucracy	stay informed of competitors, de facto standardization, 'watching over' China
Country: UK	Standards Setters, Scientists	leadership in future technologies	leadership, national relevance
Region: EU/Member States	Standards Setters, Scientists, Small Tech	enabling markets for quantum technologies	strengthening EU start-ups, finding their role in future technologies amid larger regions

5 Discussion

Our analysis foregrounds several relevant insights for the academic literature and policymaking in the field of (emerging) technology governance. Firstly, contrary to the traditional -almost commonsensical- expectation that wants market actors to be spearheading standardization (Busch, 2011; ten Oever & Milan, 2022; Yates & Murphy, 2021), we found that major industrial actors, or de facto standard-setters, may adopt 'wait and see' strategies particularly in the highly uncertain market of quantum technologies. This may indeed be a consequence of the standardization timing. Admittedly, with little evidence of workable use cases in sight, it could be argued that quantum technologies have yet to materialize their 'disruptive' potential. As such, our study differs from previous studies that explored the linkages between standards and disruptive innovation (Birkinshaw et al., 2018; Blind et al., 2023; De Keyser & Vandenbempt, 2025; O'Reilly & Binns, 2019), in that it illustrates a standardization story with little to no 'industry', happening at a time of nascent supply chains and blurry promises for disruption. In parallel, our study findings complicate the general understanding of the different cultures of and for standardization that characterize the main geopolitical actors. In other words, contrary to the established belief that wants Europe, China, and the US to have SDO-led, government-led, and market-led models for the development of standards, quantum standardization seems to be moving forward by the same counterparts across the geopolitical spectrum (i.e. standard setters).

As such, quantum standardization ended up a result of top-down institutional dynamics. In this top-down process, the creation and enabling of markets as constitutive justification for standardization represents only a small part of the various logics that drive people to the standardization room. Therefore, we conclude that quantum standardization has not emerged as a calculated policy option by governments or a rational response by market actors. Granted, some actors, such as the European 'small tech', have seen economic sense in engaging with standardization but, by and large, quantum standardization emerged as a reflexive and institutional enterprise against the 'unknown' risks and the promised future potential of quantum technologies. This finding seems to corroborate earlier scholarship on the role of standardization in emerging markets and the centrality of top-down, regulatory initiatives therein (Blind et al., 2017).

In parallel, despite the evident (geo)politics that manifest in quantum standardization, the feared 'race' for 'quantum supremacy' is unlikely to unravel in a standardization room anytime soon. With minuscule industry participation and no major commercial use case in sight, the 'geopolitical' stakes in quantum standardization are -to put it mildly- relatively modest. States, in other words, do not seem to participate in quantum standardization in a rational attempt to gear their dynamics and workings towards their national quantum projects and agendas because there is, frankly, very little to be geared.

Consequently, realist accounts of international relations are not helpful in explaining the emergence of quantum standardization as an institutional phenomenon. Indeed, if the market need is not there and the geopolitical stakes are realistically minor, one would expect states and experts to be skeptical about allocating resources to such a project. And yet, despite its infancy, quantum standardization features in the most prominent institutional initiatives worldwide and its edifice has grown to become an internationally acknowledged JTC between two of the most influential international SDOs. Central to many and diverging policy logics, quantum standardization has obtained a life of its own by forming this peculiar institutional setting where (geo)politics, quantum science, and standards coalesce to form a unique blend of (geo)political negotiations, research-led brainstorming, and inter-state bureaucracy (Mattli & Büthe, 2003; Peña, 2015).

This particular institutional setting is embedded within and (re)produces a culture that is both symbolic and material (Friedland & Alford, 1991; Thornton et al., 2012a). It is symbolic as it aspires to become the central pillar and fuel for realizing and unleashing the imagined potential of quantum technologies and it has been established to deliver precisely on this promise. In this interplay, central is the role of 'institutional entrepreneurs' (DiMaggio, 1988; Fligstein, 1997; Maguire et al., 2004); actors such as the European Commission or the UK with sufficient resources, institutional memory, and social skill in instigating the dynamics for institutional development at the regional and international level. In turn, this institutional setting is material insofar as it establishes the foundations for the development of quantum technologies, preshaping future trajectories in the process. For instance, the project on the hybridization between a quantum computer and a classical computer presupposes that the former will be 'useful' as long as it achieves some sort of 'acceleration' for the workload of the latter.

Crucially, endemic to this institutional creation is an 'angst for sense-making' by actors who chart unknown terrains with routines (e.g. standardization), tools (e.g. 'layer model'), and mental maps (e.g. 'the east vs west divide') they are familiar with (Guzzini, 2016). Coupled with an unsubstantiated fear of geopolitical competitors achieving some sort of 'quantum supremacy', quantum standardization thus becomes an institutional pressure valve for actors to relieve their ontological insecurities (Eberle & Daniel, 2022; Mitzen, 2006; Rumelili, 2020). As long as the stakes are low, this institutional setting will likely continue and evolve. But there can be no institutional guarantee that standardization will stay relevant and useful when circumstances change (e.g. through a scientific breakthrough). For this reason, the peculiarities of the current standardization landscape and its timing suggest caution against any attempts to look therein in order to foresee and stabilize expectations for the future of quantum technologies.

Our study has limitations. First and foremost, empirical evidence and its analysis are necessarily tied to the nascent level of technological and institutional progress around the development of quantum technologies and their governance. Secondly, our observation study is necessarily focused on a limited number of working groups and sessions. Insights may vary from WG to WG but plenary sessions have helped the research team in observing the general direction and progress of all WGs in CEN-CENELEC JTC 22 and IEC/ISO JTC 3. Finally, our study unfolds from within and in relation to institutions that have already advanced agendas for the development of quantum technologies. Therefore, perspectives and insights from countries and professionals that are traditionally under-represented in STEM-related, regional and international governance fora are missing. Future research, in and beyond standardization, should aim to address such limitations.

6 What does the future hold?

In this paper, we contribute to the understanding of the production of reality through science and technology in the proceduralized environment of standardization, where states, industry, and technology intersect. We provide a framework to structure the seemingly widely varying interests and explain why different actors are invested in the process of standardization as a form of technology governance. We conclude that quantum standardization is a uniquely bizarre space, a space and place where complex science meets the straitjacket of standards to (re)produce a strange institutional form where national representatives meet to hardcode and 'infrastructure' the present and future of technological trajectories. Despite operating in a nascent field, we observed how professional expertise, identities, and national strategies play out in quantum standardization and to what end(s). In doing so, we illustrate the policy logics and drivers of the actors involved to portray 'moments' in the early timeline of quantum technologies development: a future that is -by definition- unknown, but whose political economy, however, is not difficult to speculate and foresee. Whenever and wherever a scientific breakthrough occurs, it will most likely be a product of particular investments in technologies of particular dependencies. To that end, the current institutional configuration of quantum standardization and the culture of technology negotiation are no guarantees of future success or even relevance of quantum standardization.

Perhaps the best way to illustrate this is by ending on a story that serves as a powerful, albeit ironic, symbolism of the current state of affairs. It was during the typical introductory announcements at one of the standardization plenary meetings, when the then host showed a map of the emergency plan for evacuation and pinpointing at the red 'X' onto it, said: 'This, here, is the meeting point in case of emergency, but if something happens feel free to run away wherever you want'.

Funding

The research has been supported by Quantum Delta NL – Action Line 4 (AL4 – QDNL).

Contributor Statement

Conceptualization: Authors 1,2, and 3; Data Curation: Author 1; Formal Analysis: Author 1; Funding Acquisition: Author 3 and Author 1; Investigation: Author 1; Methodology: Author 1 and Author 2; Project Administration: Author 3 and Author 1; Supervision: Author 3; Writing – Original Draft: Author 1 and Author 2; Writing – Review and Editing: Author 2 and Author 3.

Use of AI

No AI tools were used in preparation for this research article.

Conflict Of Interest (COI)

The first author is also a member of NEN (Nederlands Normalisatie-instituut). We received funding through AL4-QDNL. The research was carried out in accordance with the European Code of Conduct for Research Integrity.

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