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Quantum for good through a lens of technosolutionism: A critical-constructive view

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ABSTRACT

'Quantum for Good' (Q4G) has emerged as a guiding rationale for quantum technology development, emphasising its potential to address societal challenges and serve the public good. Through this normative ambition, Q4G echoes the language of responsible innovation. At the same time, using technology to address complex social problems has been critiqued as 'technosolutionism'—the belief that technology is an effective means to solve non-technological problems. In this paper, we examine whether and how this critique applies to Q4G. We adopt a principally neutral perspective on technosolutionism, recognising both the potential and limits of technological solutions, and use this as a critical-constructive lens to assess the normative underpinnings of Q4G. Specifically, we develop a set of guiding questions to scrutinise the ethical dimensions of proposed technosolutions and apply this framework to Q4G. We argue that, to live up to its commitment to societal good and to avoid becoming a legitimising narrative for existing innovation agendas or reducing complex issues to technological challenges, Q4G must remain attentive to the ethical and sociopolitical dimensions of the problems it targets and the solutions it advances.

1. Introduction

Although most quantum technologies remain at an early stage of development and their practical applications are still largely speculative, a new discourse is taking shape around their potential societal value. Alongside narratives that position quantum technologies as a scientific, economic, and geopolitical asset, *Quantum for Good* (Q4G) has emerged as a prominent framing and rationale for quantum technology development. It refers to the leveraging of quantum technologies to address pressing societal challenges and to contribute to the public good, however defined. These aspirations are often articulated through alignment with global agendas such as the UN Sustainable Development Goals (SDGs) and, importantly, through a focus on identifying concrete quantum *use cases* that demonstrate societal benefit.

As such, Q4G embodies a normative ambition, founded on assumptions about the desirability of technological solutions and the instrumentalisation of quantum technologies in service of societal values. In this respect, Q4G echoes the language of responsible innovation (e.g. Von Schomberg, 2013) and appears to answer calls for such approaches in the quantum domain (e.g. Gasser et al., 2024)—although the extent

to which it genuinely embodies these commitments warrants closer examination.

Despite its increasing prominence, Q4G has received little critical scrutiny. While the concrete manifestations of Q4G remain nascent, it is important to examine the assumptions underpinning such efforts from the outset. Framed as delivering societal benefits, these initiatives call for ethical assessment, particularly when public resources are involved. Moreover, if the Q4G frame gains widespread endorsement, it could come to shape the impact pathways of quantum technologies in society. Thus, an explicit ethical appraisal of the notion is required to better understand its underlying assumptions and possible ramifications.

At the heart of Q4G and its orientation towards finding use cases lies a belief in the transformative potential of quantum technologies. This focus on the problem-solving capacities of technology links Q4G to *technosolutionism*: the notion that we can and should use technology to solve the challenges we face (Saetra, 2023). Technosolutionism has often been criticised for its reductive logic and the implicit innovation agendas it serves. The concept is therefore frequently treated pejoratively. Drawing on recent scholarship, we adopt a more nuanced and diagnostic use of the term, recognising both the potential and limits of

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technological solutions. Rather than dismissing technological initiatives outright, we employ technosolutionism as a—critical yet constructive—analytical lens to evaluate Q4G as a normative project.

Using the concept of technosolutionism in unpacking Q4G allows us to place front and centre the sociotechnical conditions in which quantum technology development is taking place. It enables a reflective interrogation of how technologies are framed as solutions, and how societal problems may be reshaped—or narrowed—to fit those solutions (Nydal et al., 2023). Examining Q4G through this lens, we draw attention to the risks posed by technosolutionist tendencies while also identifying opportunities for a more reflexive and responsible approach to Q4G. Thus, rather than evaluating the potential impacts of quantum technologies—often the focus of ethical analyses—we focus on the reasoning underpinning Q4G as a motivating rationale and shaping force in their development, which is particularly pertinent given the early, formative stage of these technologies (de Jong, 2025).

We begin by introducing the emergence of *Quantum for Good* as a normative ambition (Section 2), examining its core assumptions and its focus on identifying quantum ‘use cases’. We then synthesise existing accounts of technosolutionism (Section 3), and distil a nuanced view that can be mobilised to interrogate technosolutions from an ethical standpoint. Drawing on this nuanced approach, we develop four guiding questions to ethically scrutinise technosolutionism in practice (Section 4). We then apply this framework¹ to evaluate the project of Q4G, with particular focus on efforts to align quantum technologies with the UN Sustainable Development Goals (SDGs) (Section 5). We conclude with an overall assessment and suggestions for strengthening Q4G as an ethically robust normative ambition for societally attuned innovation (Section 6).

2. The emergence of quantum for good

The year 2025 has been designated by the United Nations as the ‘International Year of Quantum Science and Technology’. This initiative celebrates “100 years of quantum progress” and aims to “raise public awareness of the importance and impact of quantum science and applications on all aspects of life.” (Quantum 2025, n.d.) The prevailing tone is one of optimism about a ‘quantum-enabled future’, which is not only associated with significant economic benefits and scientific breakthroughs but also with societal progress. The perceived potential of quantum technologies to contribute to the good of society and the initiatives actively pursuing this, is what has been popularised as *Quantum for Good* (Q4G). In this section, we examine the emergence of the Q4G as a normative ambition to harness quantum technologies for societal benefit (2.1) and we reflect on the role of use case development in shaping that ambition (2.2).

2.1. *Quantum for Good* as a normative ambition

Building on a discourse that has primarily emphasised the scientific, economic, and geopolitical promise of still-emerging quantum technologies, the phrase “quantum for good” has gained traction in recent years (Vermaas & Mans, 2024; Shelley-Egan, 2025; Shelley-Egan & De Jong, 2025). The implicit reasoning seems to be that if quantum technologies could drive scientific progress, economic growth, and strategic power, they might also be mobilised for social benefit—and if we are to invest in quantum’s anticipated scientific, economic, and geopolitical gains, we should also invest in quantum initiatives oriented towards societal goals.

¹ We do not present our framework as a new addition to the landscape of RRI initiatives. We fully acknowledge that many such frameworks already exist. Our aim is instead to analyse the emerging dynamics and rhetoric surrounding quantum innovation—dynamics we characterise (without dismissing them) as technosolutionist—and to structure the resulting ethical considerations into a set of guiding questions that support a critical-constructive evaluation of Q4G.

The phrase “quantum for good” was preceded by an association of quantum technology with ambitions including ‘benefitting humanity’ (WEF, 2022), contributing to the ‘public good’ (Roberson et al., 2021), and ‘advancing society’ (Kop et al., 2024; Gasser et al., 2024). Over the past few years, the concept has featured in (semi)academic conferences, further solidifying its presence in discussions on quantum technology’s societal role.

In 2024, the United Nations International Computing Centre (UNICC) organised an event explicitly centred on Q4G and its potential applications for sustainable development (UNICC, n.d. (a)). This was followed by a conference in The Hague, organised by the UNICC, the International Telecommunication Union (ITU) and Quantum Delta NL (QDNL), which explored the “transformative potential of quantum technology for addressing global challenges” (UNICC, n.d. (b)). That same year, 2024, the UNICC and QDNL launched a partnership under the banner of Q4G, initiating a global collaborative movement “dedicated to creating positive societal, environmental, and economic impact through quantum technology” (QDNL, 2024; Quantumforgood.eu, n.d.). If 2025 is the official Year of Quantum, then 2024 can be said to have marked the formal launch of Q4G.

Broadly speaking, Q4G frames quantum technologies as a tool with which to address pressing societal challenges and the public good. The term suggests a commitment to ensuring that quantum technologies are not merely developed for commercial or military applications but are also directed toward solving social and environmental problems. Q4G reflects a normative ambition to harness the emerging capabilities of quantum technologies—such as quantum sensing, quantum computing, and quantum communication—for beneficial purposes, often aligned with broader global goals like sustainability, healthcare advancements, and economic equity. We stress ‘emerging’ or ‘potential’ capabilities here, as, while there is solid scientific ground for anticipating such applications, their practical realisation remains constrained by substantial scientific and engineering hurdles.

Concretely, Q4G is often linked to the UN Sustainable Development Goals (SDGs), with the argument that quantum technologies could contribute to fields such as climate modelling (Goal 13: Climate Action), drug discovery (Goal 3: Good Health and Well-being), and secure communication in ways that promote societal well-being. The Open Quantum Institute—a multilateral governance initiative launched in 2024—further institutionalises this agenda, explicitly promoting the development of quantum applications “for the benefit of humanity” (Open Quantum Institute, n.d.).

The Q4G narrative offers a counterpoint to the risk-based framing that often dominates discussions on emerging technologies. Q4G foregrounds the potential positive societal impact quantum technologies, reflecting a shift from—or extension of—purely scientific and economic motivations to a more values-driven approach in technological development. This can be seen against the backdrop of an emphasis on responsible research and innovation over the last two decades, focusing not only on mitigating risks but also on directing technology development toward beneficial societal outcomes. Precedents such as ethical AI and the ITU’s *AI for Good* initiative demonstrate how emerging technologies can be framed in normative terms. Q4G appears to be following a similar trajectory.

Positioning quantum technologies as a potential solution to societal challenges—or at least as a significant contributing technology to solving societal problems—helps to justify investments in their development and creates a basis for broader societal support. While this carries the risk of Q4G being used to legitimise commercial quantum agendas (as we will discuss in Section 5), it also draws much of its current credibility from existing investment in quantum’s economic and strategic potential, creating a mutually reinforcing dynamic.

Setting the ambition of ‘quantum for good’ can guide current efforts in quantum research and development and nudge them in the direction of certain application domain. However, it remains an open question as to what exactly the ‘good’ in Q4G entails and whose ‘good’ it serves. In

practice, this question is often addressed—implicitly—through the active search of ‘use cases,’ to which we turn next.

2.2. In search of ‘use cases’

From the outset, Q4G has been presented as an effort to identify societally beneficial ‘use cases’. The term *use case* originated in software engineering, where it referred to the technical requirements and user interactions involved in operating a system (Jacobson, 2004). Initially, use cases functioned as structured descriptions of user journeys, instrumental in designing interfaces and drafting user manuals. Over time, the concept expanded into business modelling, where it came to include strategic considerations alongside technical specifications.

In more recent years—particularly in the context of emerging technologies such as artificial intelligence—the term has been used to denote targeted applications designed to address specific business challenges (e.g. Chui et al., 2018). Within the domain of quantum technologies, and especially under the banner of Q4G, the notion of use case has widened further. It no longer refers solely to existing uses or near-term applications. Instead, it increasingly appears to function as a way of identifying prospective opportunities and articulating normative goals that drive mission-oriented innovation, often reaching beyond the business realm into broader societal aspirations.

The active search for use cases has become a central theme in Q4G efforts. For example, the Open Quantum Institute explicitly aims to ‘realise the full potential of quantum computing by accelerating the development of use cases relevant to achieving the SDGs, leveraging the combined forces of researchers, developers, entrepreneurs, and United Nations and large NGO innovation cells’ (Open Quantum Institute, n.d.). Similarly, the two Q4G conferences mentioned in Section 2.1 prioritised identifying quantum use cases.

The search for Q4G use cases can be understood as a specific operationalisation of its broader normative ambition oriented toward developing technological responses to societal challenges. This approach reflects a logic often described (and at times criticised) as *technosolutionism*. The following section examines this logic in greater depth.

3. Technosolutionism: from pejorative term to critical lens

To examine whether and how critiques of technosolutionism apply to Q4G, we need a comprehensive account of what these critiques entail. In what follows, we synthesise the state-of-the-art discussion about technosolutionism. We begin by outlining the main critical perspectives (Section 3.1), before turning to more nuanced approaches that treat technosolutionism not as inherently good or bad, but as a context-dependent phenomenon warranting critical evaluation (Section 3.2). Beyond providing an overview of the debate, this discussion highlights the conditions under which a technosolution may become ethically problematic. In Section 4, we build on these insights to propose a set of questions to guide such evaluations.

3.1. Critical accounts of technosolutionism

In the face of complex societal challenges, technological innovation is often promoted as the path forward. Indeed, we ‘innovated’ ourselves out of the COVID-19 pandemic through the development of vaccines—yet debates about the use of AI and Big Data in the development of apps for tracking infections and in pandemic control highlighted the controversies surrounding technological responses to social problems (Siffels & Sharon, 2024).

Technological solutions to social problems have drawn renewed scrutiny against the backdrop of new technological advancements such as Artificial Intelligence and geoengineering (O’Neil, 2017; Broussard, 2019; Coeckelbergh & Saetra, 2023; Saetra, 2023; Sheikh, Prins & Schrijvers, 2023; Stein, 2024). The concept of ‘technosolutionism’

provides a useful lens for understanding these discussions. Technosolutionism centres on the idea that we should mobilise technology to solve the challenges we face (cf. Saetra, 2023).² Thus technosolutionism always implies a degree of confidence in technology’s potential to address complex societal issues—confidence that, at times, may verge on overconfidence or even hubris (Johnston, 2018).

Criticism of technosolutionism is longstanding and multifaceted. It ranges from fundamental objections to framing social problems as technical ones (Naess, 1973; Morozov, 2013) to more targeted concerns about the unintended harms and ethical blind spots of particular technologies (Broussard, 2019; Nydal et al., 2023; Siffels & Sharon, 2024). These strands of criticism reflect Scott’s (2011) distinction between philosophical and practical critiques. Philosophically, technosolutionism is criticised for promoting a narrow mindset in which technological progress becomes the default mode of problem-solving, marginalising non-technological or social alternatives and excluding existing social practices as valid solutions.³ Practically, it is challenged for failing to solve problems, creating new ones, or reinforcing flawed systems that ought to be transformed rather than superficially repaired.⁴ Notably, these critiques may overlap but are not always aligned: one can criticise a specific intervention without rejecting the problem-solving capacities of technology wholesale.

Philosophical and practical critiques of technosolutionism converge in concerns about how problems are constructed. A core critique of technosolutionism rests on the poor construction of the technosolutionist problem such that the problem definition follows the solution and is twisted to fit the solution, rather than the opposite way around (Siffels & Sharon, 2024). This directionality is especially problematic with respect to public policy making, where good problem construction implies careful deliberation and discussion of alternative solutions.

Moreover, this ‘technology first’ approach is *backward-looking*, reflecting a “reformulation or recasting of an existing phenomenon as a problem (...)” (Siffels & Sharon, 2024: p.4). For example, the existence of smart technology—such as sensors in the home that can collect data relevant to sleep cycles—can lead to sleep itself being recast as a ‘problem’ to be solved. By contrast, a forward-looking approach would start from the problem and then consider possible solutions, avoiding a narrow or forced definition of the problem based solely on the capabilities of existing technologies. This problem-first directionality is more likely to yield well-constructed problems, because the problem ‘presents

² *Technosolutionism* is often discussed alongside the notion of the *techno-fix*. While some use the terms interchangeably, others have explicitly distinguished between them (Scott, 2011; Saetra & Selinger, 2024). In this paper, we do not draw a sharp distinction between the two; however, we primarily adopt the term *technosolutionism* because it refers less to a specific technological intervention and more to an underlying logic or mode of thinking. This emphasis on process and orientation aligns more closely with our analytical focus.

³ Relatedly, Nachtwey and Seidl (2024) describe a “solutionist ethic” that has become central to the embedding of new technologies in society. This ethic is founded on the notion that solutionism comprises a new order of worth, in which *value* derives from solving social problems through technology.

⁴ Scott illustrates these critiques through Timothy LeCain’s historical study of pollution from copper smelting in the United States (LeCain, 2004). The problem in question was the removal of sulphur dioxide gas emissions – resulting from smelting processes – from the immediate environment, in addition to a conflict between mining companies and local communities. In order to address the problem, chemists adopted technological solutions, including, in one case, converting the pollutant into sulphuric acid to produce fertiliser—a seemingly elegant “win-win” fix. Yet this solution merely relocated the problem: the transformed and relocated environmental toxins – taken up in the fertilisers – had unforeseen environmental consequences. Furthermore, the ‘fix’ preserved the polluting industry itself, displacing more transformative alternatives. This example highlights how technosolutionism can manifest as narrow problem framings, unintended consequences, and the entrenchment of existing systems under the guise of innovation.

itself', emerging naturally from real-world relevance.

3.2. Nuanced views of technosolutionism

Several scholars have argued for a more open and context-sensitive view of technosolutionism (Ruser & Machin, 2016; Nydal et al., 2023; Saetra & Selinger, 2024) and to value concepts such as 'technosolutionism' and 'techno-fix' as tools for understanding the roles technologies play in modern society (cf. Scott, 2011; Ruser & Machin, 2016). Here, we bring them together to build a nuanced view of technosolutionism.

A first argument highlights the need to 'politicise' technosolutions: being attentive to the *social and political context* in which they emerge and are discussed. According to Ruser and Machin (2016), for example, it is crucial to scrutinise both the techno-fix narrative *and* its critique, as they both risk obscuring the deeper socio-political dynamics at stake—particularly the 'depolicitisation'⁵ of democratic negotiation.

They illustrate this through two narratives about geoengineering. The post-growth narrative advocates for systemic change: reducing emissions and transforming high-consumption, fossil-fuel-based economies. The techno-fix narrative, in contrast, offers a 'second best' path—using technological innovation to address climate change without altering lifestyles. While these narratives differ in their vision of change, Ruser and Machin argue that both fall short in addressing the political questions embedded in technological development (p. 438). Notwithstanding questions about the feasibility of geoengineering itself, issues of authority and accountability—such as who has the power to approve and implement geoengineering experiments, and who bears responsibility for their outcomes—are often side-stepped. These concerns are especially salient given that only a few powerful, wealthy states are likely to possess the resources to deploy such technologies.

However, the 'techno-wariness' enveloped in the critique of the technofix narrative can also obscure crucial questions of power: Who decides whether these technologies can be used or not? Moreover, rejecting technosolutions outright may risk denying resources or interventions to those who could benefit most (Wieners et al., 2023). In both acceptance and rejection of technological solutions, political judgment and social negotiation remain essential. In what follows, we will refer to these aspects as the 'sociopolitical dimensions' of technosolutions.

Ruser and Machin thus emphasise that technologies are always socially embedded and cannot be meaningfully accepted or dismissed outside political processes. As they write, 'it cannot be instituted or rejected prior to political decision-making, but rather necessarily involves ongoing social and political analysis' (2016, p. 437). Thus, a truly critical (yet nuanced) approach to technosolutionism must rise beyond deep scepticism and instead engage with the sociopolitical dimensions of both innovation *and* its critique.

A second argument points to the need to critically evaluate the ambiguity of techno-fixes and their *scope*. This relates to the practical criticism that such fixes often preserve systems that arguably should be dismantled or transformed for better alternatives. Their ambiguity lies in the fact that their perceived success depends heavily on how, and by whom, success criteria are defined (see also Scott 2011, p.225).

Scott warns of the need to be cognisant of and to manage expectations regarding what technological fixes can achieve, and the new kinds of problems they might bring about. At the same time, he argues that we should not dismiss their potential too readily. A technofix, he notes, '(...) may simply be the most appropriate response at the moment, or the best that can be done at this time' (p. 225), offering policymakers '(...) more options and additional means for addressing problems' (p. 225).

In a similar vein, Saetra and Selinger (2024) opine that 'addressing

⁵ We define depoliticisation as the process of framing issues, decisions, or policies as non-political, often by presenting it as purely technical, inevitable, or outside the scope of public debate.

symptoms does not necessarily mean one is ignorant of or indifferent to the underlying causes' (p. 4.). A technofix may offer a palliative or 'band-aid approach'—and band aids are, at times, necessary or ethically appropriate in the short term. The point is, rather, to remain attentive to the full extent of the problem and the limits, in terms of time or scope, of the technosolution.

A third argument centres on the need to question the *legitimacy* of technosolutions. One version of this argument is closely related to the ambiguity argument and calls for concepts like techno-fix and technosolution to be stripped of their normative baggage, and instead evaluated in terms of plausibility, appropriateness, and potential effectiveness. Treating these as normatively neutral concepts creates room for a more careful and less dismissive evaluation of technosolutions—one that avoids both presuming bad faith or naïveté (Saetra & Selinger, 2024). Such a constructive approach allows for the possibility of a technological framing of a problem being a valid one.

While also concerned with the legitimacy of technosolutions, Nydal et al. (2023) highlight the *normativity* of technosolutionist approaches. Nydal et al. (2023) emphasise that technofixes can lead to a kind of 'moral desensitisation' that may come about as a result of technofixes hiding or backgrounding the specific conditions of their success:

'Technologists' ability to background the conditions of their success calls attention to a key aspect of the techno-fix objection. The common techno-fix objection expresses an important concern of something being forgotten or not receiving appropriate attention. The *real* moral issues (...) are prevented from presenting themselves and are silenced in disturbing ways.' (p. 3)

The authors thus emphasise that techno-fixes carry moral implications, and that these can be obscured when the social conditions enabling a technological solution are pushed into the background (p.3). Their concern is not only that such conditions are forgotten, but that the underlying moral issues they embody are prevented from coming into view at all—hence, de-moralising the problem.

The issue here is one of technological opacity (cf. Vallor, 2016) and its ethical consequences: the technofix can conceal the moral stakes of the issue to which it responds (e.g. climate change), thereby enabling continued, unreflective practices without fostering awareness or engagement with the underlying problem.⁶ Nydal et al. (2023) conclude that such morally problematic opacity can be mitigated by placing the technology 'in plain view': explicitly acknowledging the problem a technological intervention seeks to address, even if it does not structurally resolve it, and making visible the conditions that render the intervention possible (p. 14).

Ultimately, they argue that the moral legitimacy of tech-fixes must be evaluated case by case, to assess whether the technology silences morally relevant implications and facilitates problematic, unreflective behaviour, and to look for ways to sensitise people to the problem that is being backgrounded by the technological intervention.

Together, these arguments offer a more a more nuanced understanding of technosolutionism—one that recognises their potential to contribute to problem-solving, while also remaining alert to their limitations, risks, and socio-political dimensions. By shifting focus from blanket endorsements or rejections to questions of legitimacy, scope, and power, this discussion helps move beyond a binary view of technological fixes. This perspective opens up space for more reflective engagement with technosolutions; engagement that asks not only what

⁶ Nydal et al. (2023) demonstrate this with a description of a Spanish viticulture innovation in which technological efforts are made to solve the problem of alcohol levels in wine. This problem is brought about by the effects of climate change. Bioengineered yeasts mitigate the alcohol content of wine, while at the same time they "(...) may become another hidden techno-fix that operates behind the scenes and hides both the role of the technology and the seriousness of the climate change problem (...)" (p. 15).

technosolutions solve, but how, for whom, and at what cost. This, in turn, provides a foundation for developing practical guidelines for an ethical analysis of initiatives such as Q4G.

Following Scott (2011) and Ruser and Machin (2016), we contend that dismissing technological solutions—or positioning them as inferior to non-technological ones—misses two important points: the central role of technology in human life, and the need to assess whether a given technological intervention is effective and appropriate in context. The issue is not technology per se. Rather, problems arise when technology is treated as *the* solution to challenges that are fundamentally structural or social in nature. Structural issues typically require structural change, and social problems often call for social responses. Technology may well contribute to such responses, but it can also be misapplied as a superficial 'quick fix' that leaves underlying causes and the social dimensions of the problem largely untouched.

Building on this discussion, we take technosolutionism to be a morally neutral concept: neither intrinsically beneficial nor inherently suspect. Whether a technosolution becomes ethically problematic depends on several factors, including its sociopolitical implications, the ambiguity of its success criteria, and the extent to which it obscures morally relevant aspects of the problem at hand. Mobilising these insights, the next section develops a set of guiding questions for examining these ethical dimensions in concrete cases of quantum technology development.

4. Guidelines for an ethical analysis of *Quantum for Good*

Drawing on the discussion in Section 3, this section proposes an evaluative framework to support the ethical scrutiny of technosolutionist interventions. In doing so, we shift from a descriptive-analytical orientation to a more normative and practice-oriented one.

The framework is composed of guiding questions that can inform critical-constructive, ethical engagement with emerging or proposed technosolutions. These questions can guide *ex ante* analysis, supporting reflection *before* the technosolution has been conceived, as well as 'real-time' analysis, guiding ongoing evaluation once a concrete proposal has taken shape. While *ex ante* questions support anticipatory reflection and norm sensitivity in the early stages of innovation, real-time questions allow for ongoing critical engagement as proposals take shape. Although all questions may also be applied *ex post*, their anticipatory function diminishes at that stage.

4.1. Guiding questions to scrutinise technosolutions

From the critical accounts of technosolutionism—both philosophical and practical—we take *problem construction* as a central issue for ethical scrutiny. To interrogate the problem a technological intervention is aiming to address, it is also relevant to consider whether it has a *backward-looking* or *forward-looking* orientation. This leads to our first question:

1. Problem construction: *How is the technosolutionist problem constructed? Does it have a backward or forward-looking orientation?*

From the nuanced accounts, we take the *sociopolitical dimensions* of technosolutions (and their critique), the *scope* of the issued problem (and its proposed solution), and the *legitimacy* of both the problem and its technological intervention as key concerns for scrutiny. This gives rise to questions about the motivations underlying a technological approach, the definitions of success, unintended consequences, and the possible obfuscation of broader moral or structural issues:

2. Sociopolitical dimension: *Have the motivations underlying the (proposed) technosolutionist approach been scrutinised? Which criteria inform the proposed technosolution and according to which criteria of success? Who defines these criteria?*

3. Scope: *What is the temporal scope of the technosolutionist intervention? Is it planned to be a temporary or longer-term solution? Have possible societal and environmental impacts been considered or identified?*

4. Legitimacy: *Can the proposed technological approach be considered a plausible, appropriate, and potentially effective response, given the current context?⁷ Which practices are being sustained by this solution? Are efforts also made (elsewhere) to address more structural aspects of the problem?*

Together, these questions comprise a framework for assessing technosolutions in practice, enabling an open yet critical interrogation of technosolutionism in practice. In the next section, we use these questions to scrutinise Q4G as the normative ambition to leverage quantum technologies for addressing social challenges such as climate change, healthcare, and hunger.

Overall, this framework responds to the need articulated by Siffels and Sharon (2024) to develop ethical interventions *ex ante*, ensuring that ethical scrutiny occurs before problematic technosolutionism becomes entrenched in the justification, design, and deployment of a technology. With these guiding questions, we offer a means to critically assess the notion of Q4G in its embryonic stages, particularly the search for quantum use cases, at a point when there is still space to effectively debate the ethical and sociopolitical dimensions of proposed technosolutions.

5. Assessing *Quantum for Good* through a lens of technosolutionism

Building on the preceding discussion of technosolutionism, we assess Q4G both as a normative ambition and with respect to how it has been operationalised through the search for use cases. We follow the guiding questions outlined in the previous sector regarding problem construction (5.1), socio-political dimensions (5.2), scope (5.3), and legitimacy (5.4).

Throughout this analysis, we take the Open Quantum Institute (OQI) as a concrete example of a Q4G initiative, dedicated to 'the development of applications for the benefit of humanity' (Open Quantum Institute, n.d.). As the most structured effort to date to advance the Q4G agenda, the OQI offers a valuable point of reference for our analysis. We draw on the use cases that the OQI has formulated to mobilise quantum technologies in support of the SDGs, using these as illustrative examples of envisaged quantum technosolutions.

Table 1 summarises the use cases formulated by the OQI. Both the selected SDG-related problems and their proposed quantum approaches are taken directly from the OQI White Paper (Open Quantum Institute, 2024). It is important to note that OQI's own readiness rankings indicate that the vast majority of these proposed applications remain at an early, conceptual stage, mostly expressed as initial ideas or high-level proposals with little technological maturity at present. In the fifth column we highlight aspects of the proposed quantum solutions that may raise ethical concerns. We focus primarily on ethical concerns directly associated with the specific use case, including those arising from exacerbating existing inequalities or the inheritance of risks associated with other technologies (e.g., algorithmic bias). Some of these concerns are reminiscent of issues arising around other new and emerging technologies. That does not, however, make them less deserving of our attention in the context of quantum technologies; on the contrary, as has been argued elsewhere (Shelley-Egan & De Jong, 2025), attending to these continuities—rather than fixating on what is novel—enables us to draw on analogous discourses and avoid reinventing the wheel (see also Swierstra and Rip 2007).

Beyond the considerations raised by the specific use cases, we acknowledge broader ethical issues that cut across all proposed use cases, particularly (global) accessibility and dual-use risks. Given the high cost and resource-intensive nature of current quantum technologies, accessibility constitutes a systemic ethical concern that extends beyond any individual use case. Likewise, the (aspirational)

⁷ Assessing this involves both technical and non-technical considerations, which may require different forms of expertise.

Table 1

OQI's quantum use cases: a selection of SDG-related problems and their proposed quantum solutions as presented in the OQI's White Paper (2024).

SDG	Theme	Problem	Proposed quantum solution	Possible ethical concerns
2 – Zero Hunger	Plant Genomics	Unlocking the genetic basis of complex plant traits for sustainable agriculture is hindered by the biological complexity of crop genomes and the computational limitations of current methods for analysing high-dimensional genomic data.	Quantum computing offers the potential to overcome these bottlenecks by accelerating genomic data analysis and enabling the simulation of complex gene networks, thereby supporting more efficient and scalable gene editing for improved crop performance.	<i>Concentration of power:</i> Quantum-accelerated gene editing may reinforce existing monopolies in agribusiness by giving large corporations disproportionate access to advanced tools and proprietary genomic data, potentially marginalising smallholder farmers, restricting biodiversity, and deepening global agricultural inequalities. <i>Biodiversity and resilience:</i> Optimising for specific traits could lead to reduced crop genetic diversity, increasing vulnerability to pests, disease, or climate shocks. <i>Ethical acceptability of gene editing:</i> The use of quantum tools to accelerate gene editing could intensify public concern over the naturalness and moral legitimacy of modifying plant genomes at scale.
	Last-Mile Food Delivery	Inefficient last-mile food delivery, especially for smallholders, leads to significant food waste, high costs, and environmental harm, due to the computational intractability of optimally solving complex routing problems like the Vehicle Routing Problem (VRP).	Quantum computing, particularly through hybrid optimisation approaches and QUBO formulations of VRP, could enable more efficient and scalable logistics solutions that minimise waste and improve the accessibility and affordability of food distribution systems.	<i>Equity of benefit distribution:</i> There's a risk that quantum-enhanced logistics tools primarily benefit large corporations, leaving smallholders and low-income communities underserved or excluded. <i>Environmental trade-offs:</i> While aiming to reduce food waste, quantum-optimised routing could inadvertently increase energy consumption elsewhere (e.g., through expanded delivery networks or increased packaging), offsetting sustainability gains.
3 – Good Health and Well-Being	Accelerating Novel Antibacterial Discovery	The discovery of novel antibiotics is hindered by limited predictive tools for antibacterial activity and compound accumulation, making the exploration of vast chemical space slow, expensive, and heavily reliant on empirical testing.	Quantum reservoir computing and quantum simulation offer a promising approach to improve in-silico prediction of molecular properties, enabling more accurate, efficient, and scalable discovery of effective antimicrobials to combat drug-resistant infections.	<i>Environmental impact:</i> Accelerated drug development could increase pharmaceutical waste or ecological disruption if not managed responsibly. <i>Alignment with public health priorities:</i> Quantum drug design may prioritise profitable compounds over urgent global health needs, potentially neglecting equitable access and antimicrobial resistance challenges.
	Predicting Gastrointestinal Cancer	The early detection of gastrointestinal cancers is hindered by the sheer volume of medical imaging data generated by non-invasive diagnostic technologies, overwhelming both human and classical computational resources.	Quantum machine learning approaches—such as quantum neural networks and quantum support vector machines—could enable more efficient and accurate image analysis, supporting real-time diagnosis and earlier intervention for colorectal cancer.	<i>Impact on clinical practice:</i> Automated quantum diagnostics might reduce critical clinical judgment or human oversight.
6 – Clean Water and Sanitation	Water Leak Detection	Urban water systems suffer from significant water loss due to leaks, but optimally placing a limited number of sensors to detect these leaks is a complex, computationally hard problem that current methods address inefficiently.	Quantum optimisation techniques, particularly leveraging neutral atom quantum processors, could efficiently solve the sensor placement problem on large, complex water networks, enabling more effective leak detection and reduced water loss.	<i>Dependence on technology:</i> Reliance on complex quantum optimisation systems may reduce investment in simpler leak detection and maintenance efforts. <i>Data Security:</i> Sensor networks controlling critical infrastructure could be vulnerable to hacking or misuse, posing risks to water supply reliability and public safety.
	Eliminating “Forever chemicals” From Water Sources	PFAS (“forever chemicals”) are highly persistent, toxic contaminants in water that are extremely difficult to break down chemically, posing severe health and environmental risks worldwide.	Quantum simulation methods can accurately model the complex chemical bonds in PFAS molecules, enabling the design of more effective materials and processes to destroy these contaminants and improve water treatment technologies.	<i>Environmental safety:</i> New materials or processes designed to break down PFAS might generate harmful byproducts or have unforeseen ecological impacts if not thoroughly tested.
7 – Affordable and Clean Energy	Molecular Docking to Clean up Pollution	Phenol and other persistent organic pollutants in wastewater pose serious health and environmental risks, yet current degradation methods are energy-intensive, costly, or slow, limiting effective remediation.	Quantum simulation combined with machine learning can accurately model enzyme-phenol interactions at the molecular level, enabling the design of more efficient bioremediation catalysts and treatment strategies.	<i>Social and economic displacement:</i> More efficient pollution cleanup might reduce demand for existing industries or jobs related to traditional remediation methods, affecting livelihoods without adequate transition planning.
	Layout of Turbines in a Wind Farm	Optimising wind farm turbine layouts to maximise energy output is a complex, computationally intensive challenge due to wake effects and large-scale variables, limiting efficiency and renewable energy potential.	Quantum optimisation methods, including QUBO formulations and quantum annealing, offer a promising approach to rapidly identify optimal turbine configurations, enhancing wind farm efficiency and supporting the transition to clean, affordable energy.	<i>Environmental impact:</i> Algorithmic decisions may overlook local ecological or social consequences.

(continued on next page)

Table 1 (continued)

SDG	Theme	Problem	Proposed quantum solution	Possible ethical concerns
	Smart Grid Management	Managing large-scale electrical grids efficiently is computationally challenging due to the complexity of real-time optimisation, integration of uncertain renewable energy sources, and balancing multiple objectives such as cost, emissions, and stability.	Quantum optimisation algorithms like QAOA offer promising ways to explore vast solution spaces for grid management problems, enabling faster, more efficient energy distribution and improved integration of renewables to support sustainable, resilient energy systems.	<i>Applicability challenges in low-income countries:</i> Quantum optimisation solutions may face barriers such as limited technical infrastructure, expertise, and resources, potentially hindering equitable deployment in regions planning new energy systems. <i>Security risks of quantum-controlled infrastructure:</i> Reliance on quantum optimisation for critical systems like grid management raises concerns about vulnerability to cyberattacks, system failures, or misuse, threatening energy security and stability.
13 – Climate Action	Catalytic Carbon Capture	Accurately modelling and optimising catalytic processes and materials for carbon capture is computationally demanding due to the complexity of molecular interactions and the vast chemical space involved, limiting the development of efficient, scalable solutions to reduce CO ₂ emissions.	Quantum machine learning methods like Quantum Generative Adversarial Networks (QGANs) can overcome classical limitations by efficiently exploring complex chemical spaces, enabling the discovery of advanced catalysts and materials that improve carbon capture performance and accelerate climate action.	<i>Environmental trade-offs:</i> Focus on carbon capture might divert attention from emission reduction or social justice in climate policy.

technological capabilities on which these use cases rely carry inherent dual-use potential, with possible beneficial and harmful applications.

While these general concerns are important, they sit slightly apart from our central aim of evaluating the proposed use cases as *technosolutions*. Our analysis therefore keeps these cross-cutting issues in view, but focuses on the ethical questions that arise directly from positioning quantum technologies as solutions to SDG-related problems.

Furthermore, we do not examine each case in detail here; instead, we primarily use them to illustrate key issues in our analysis of the broader Q4G frame. What follows should thus not be read as an ethical assessment of the OQI's use cases, but rather as a preliminary effort to highlight broader technosolutionist tendencies in Q4G initiatives that warrant closer ethical attention.

5.1. Problem construction

A solution looking for problems

What, precisely, is the 'good' in Q4G? The term typically functions as an umbrella concept for quantum technology applications presumed to serve the public good. The OQI defines the 'good' of Q4G through alignment with the SDGs, translating broad societal aims—such as health, food security, and climate action—into technically addressable sub-problems (e.g. drug optimisation, supply-chain logistics). This can be understood as an attempt to channel quantum innovation towards socially desirable goals and thus resonates with responsible innovation ambitions.

The inherent assumption is that quantum technologies will be beneficial; echoing a broader solutionist logic in which emerging technologies are treated as inherently valuable, even before feasibility or effectiveness is demonstrated. This reflects a largely *backward-looking* orientation: it begins with quantum's perceived potential and works backwards to identify problems that can be reframed to match. So, although Q4G appears to start from real-world challenges (e.g., the SDGs), the technological means appear predetermined.

This 'technology-first' approach can be problematic for two reasons. First, it risks shaping problem definitions around what quantum might address, rather than around actual social priorities. Societal challenges may be broken into quantum-amenable fragments—not because these are the most urgent or impactful entry points, but because they best align with quantum's anticipated capabilities. This can lead to the SDGs functioning primarily as a menu of potential application domains. If the broader social and political dimensions of these challenges are not

explicitly acknowledged, OQI's engagement with the SDGs risks being seen as instrumentalising them to serve an innovation agenda. This concern becomes more salient when claims of working 'for good' are emphasised. To guard against mere instrumentalisation, it is important to show how quantum initiatives contribute meaningfully to the SDGs' normative commitments—and to be transparent about their limits.

Secondly, prefiguring a quantum solution risks sidelining alternatives that may be more effective, context-appropriate, or ethically preferable. For instance, while climate modelling is often cited as a prime Q4G use case, classical computing methods may remain more practical and scalable in the near term—not least given the projected energy demands of quantum computers large enough to perform such modelling (see Table 1). Moreover, reframing complex social challenges as technical problems risks narrowing their scope and depoliticising them. This is not a fault of the OQI's mandate—its mission is explicitly technocentric—but of the expectations placed on what technosolutions can achieve for systemic challenges like the SDGs. To avoid overlooking the social, economic, and political dimensions of these issues, it is crucial to recognise the limits of technosolutions. Quantum innovation should be positioned as one tool within a broader, multi-faceted effort to advance the SDGs, not as a stand-alone solution.

5.2. Sociopolitical dimensions

Motivation: Good for whom?

The motivations behind Q4G are normatively framed: to benefit society, address global challenges, and support the public good. This also holds for the OQI's initiative to leverage quantum technologies for the SDGs. In this way Q4G is being positioned as a socially responsible technology initiative, or simply: responsible innovation. However, these aspirations 'for good' remain under-scrutinised: whose good, by which values, and at what cost?

Such questions are not peripheral—they are essential for evaluating both the urgency and the legitimacy of proposed quantum interventions. Yet within the current Q4G discourse, these questions are rarely addressed in a systematic way, that is, in a structured (not ad-hoc) and comprehensive manner, taking all relevant aspects into account across use cases and initiatives. As a result, the label 'for good' risks functioning more as a normative 'vener' than a genuine, substantive ethical commitment. Without critical engagement with the notion of good Q4G risks becoming little more than an ethics-washed version of 'quantum for profit'.

Take the OQI's use case of last-mile food delivery which aims to use quantum optimisation to reduce inefficiencies in food distribution systems. The envisioned outcome is the minimisation of waste and delivery costs, thereby contributing to SDG 2—Zero Hunger. But if this use case is implemented in settings where food scarcity is not a pressing issue—or if the primary beneficiaries are commercial logistics providers in high-income countries—then we must ask: Which hunger problem is actually being addressed, and for whom?

This example shows how a technical problem—optimising distribution—can be framed as contributing to a social goal, even when its real-world impact on that goal remains unclear or marginal. It underscores the risk that technological aspirations, rather than ethical urgency or social need, is driving the selection of use cases.

Criteria for success: Technical progress as social value

Because Q4G is loosely defined, the criteria for judging its success are similarly open-ended. While initiatives such as those of the OQI link quantum innovation to the SDGs, progress is often described in terms of technical achievement or application potential, rather than demonstrated benefit for people or communities. This reflects an assumption that if quantum tools can be applied to domains such as drug discovery, logistics, or climate modelling, social value will automatically follow.

To ensure that technical achievements translate into genuine public benefit, however, assessments of viability, scalability, and desirability in real-world social contexts are essential. Equally, the process of setting priorities and defining success needs to involve those most affected by the challenges Q4G seeks to address. At present, decisions appear concentrated among institutional actors and technology developers, reinforcing a technocratic model in which technical advancement is equated with progress. In complex social domains such as hunger, health, and climate, success cannot be inferred from what is technically possible; it must be negotiated and socially determined.

The OQI's antimicrobial resistance (AMR) use case illustrates the limitations of purely technical approaches to global challenges. It proposes using quantum machine learning to accelerate antibiotic discovery, a goal aligned with SDG 3—Good Health and Well-being. The proposed solution centres on expanding the regions of chemical space that can be simulated, improving *in silico* predictions, and enhancing molecular modelling. While these are valuable scientific aims, they do not engage with the social and political factors that ultimately determine whether new antibiotics are equitably accessible and effectively used, which is crucial to genuinely addressing SDG 3.

Again, this is not a criticism of the OQI's approach—its focus is rightly technical—but it highlights a broader point: if quantum technologies are to contribute meaningfully to SDG 3, questions of access, distribution, and stewardship—particularly in low- and middle-income countries, where AMR burdens are greatest—must also be addressed.

5.3. Scope

Temporal scope: Long trajectories, urgent challenges

Q4G is imagined as a long-term vision, aimed at tackling major societal and global challenges. The search for use cases can be understood as identifying near- or mid-term goals that contribute to these challenges. Such use cases often highlight what quantum technologies *might* achieve, but their actual social value—especially in the near future—remains uncertain, limited, or difficult to demonstrate.

The tension here lies in the gap between the urgency of the challenges (e.g. food insecurity, antimicrobial resistance, climate breakdown) and the extended, uncertain timelines of quantum technology development. Designing interventions around capabilities that do not yet exist gives rise to the question of whether quantum technologies can be legitimately linked to such concrete and urgent problems, when their viability has not been proven yet.

For example, the OQI's use cases of optimising last-mile logistics and modelling in plant genomics *might* contribute to SDG 2—Zero Hunger, but they might not address the most pressing forms of hunger or crop vulnerability in practice. If meaningful impact is only expected decades from now, how does this serve problems that require immediate intervention? Without clarity about time horizons, there is a risk of overclaiming relevance, or even displacing resources from more immediately effective approaches.

Even modest attempts to align quantum initiatives with the SDGs carry potential risks when they rely on speculative interventions, particularly if public funding, policy support, or state endorsement is involved. Such investments could, in principle, divert attention from more proven or immediately effective responses. The extent to which this occurs in practice remains to be traced and warrants further investigation. Framing these speculative quantum initiatives as 'contributions' despite their uncertain impact can obscure these trade-offs and create a misplaced sense of urgency or appropriateness.⁸ Moreover, investment in commercial and security-oriented quantum development may be mobilised to bolster the credibility of Q4G initiatives, creating a legitimising dynamic that persists even in the absence of successful practical applications in those domains.

Impact: Techno-optimism outpacing ethical reflection

While the language of *intended* impact is prevalent, there is little evidence of systematic engagement with potential *unintended* consequences, distributional effects, or environmental costs of scaling quantum technologies (see Table 1). Generally, key issues—such as the energy demands of quantum computing, material extraction for hardware, or the carbon footprint of data infrastructure—remain underexposed in the Q4G discourse. This raises concerns that the techno-optimism that drives Q4G is outpacing careful ethical and ecological consideration.

5.4. Legitimacy

Technical subsidiarity: Is quantum the best fit?

Q4G rarely claims that quantum is the *only* solution to societal challenges, yet it often presents quantum approaches as uniquely positioned to address socially relevant problems. Without systematically comparing these proposals to non-quantum alternatives, advocacy for quantum solutions risks obscuring potentially more effective or context-appropriate approaches. For instance, while quantum-enhanced modelling for drug discovery or climate forecasting may be technically exciting, it is not always clear whether these approaches offer more value—socially, ethically, or economically—than existing approaches.

This raises the core question of *technical subsidiarity*: Is quantum truly the best technological fit for a given problem, or is it being advanced primarily because it aligns with strategic priorities, funding opportunities, or scientific enthusiasm? In many use case framings, this legitimacy question is bypassed in favor of 'finding a fit' for quantum rather than critically evaluating whether quantum offers the *best* solution (see also our discussion of problem construction).

Technofix or system fix?

Beyond technical fit, legitimacy also depends on social and ethical appropriateness of the proposed solution. As discussed in 5.1, Q4G's focus on use cases tends to cast global challenges as technical problems to be solved, rather than complex systems shaped by structural inequalities, political choices, and economic power. Effectively addressing

⁸ This tension between promised benefits and uncertainty is a recurring pattern across emerging technologies, and not unique to the quantum domain.

issues such as climate change, inequality, and global health requires more than technical innovation; it also requires systemic change of how we live our lives and organise our societies.

By focusing on technological mitigation of symptoms, many Q4G proposals risk obscuring the need for broader interventions to tackle root causes. For example, while quantum-enhanced carbon capture could aid climate mitigation, emphasising this technological solution could draw attention and resources away from other systemic measures—such as emission reductions and climate justice initiatives—that are essential for effectively addressing climate change. Similarly, quantum-enabled antimicrobial discovery could accelerate drug development, but without accompanying efforts to address global health inequities, its contribution to improving global health will remain limited.

Importantly, this is not a critique of Q4G per se, but of how its role is positioned and legitimised. Whether quantum technologies are appropriate or desirable solutions is not a question that can be answered in general terms. This must be assessed case by case, in relation to specific contexts, needs, and opportunity costs. For Q4G to be a form of responsible innovation and a legitimate approach, it must invite this kind of critical scrutiny—not assume its own relevance by default.

6. Conclusion and discussion

Quantum for Good (Q4G) has recently emerged as a normative ambition to harness quantum technologies for the public good. Initiatives under this banner aim to align quantum innovation with societal challenges, most notably by identifying use cases promising social benefit.

This approach—starting from quantum's technical potential and seeking problems to match this potential—bears the hallmarks of *technosolutionism*. In this paper, we used technosolutionism as an analytical lens to critically yet constructively examine Q4G. We adopted a nuanced perspective that interrogates how problems are constructed, how sociopolitical dimensions are addressed (or sidelined), and how scope and legitimacy are framed. Drawing on recent scholarship, we distilled a set of guiding questions to evaluate the ethical dimensions of the technosolutions promoted under the banner of Q4G.

Through its normative aspiration, Q4G gestures towards more responsible and normatively attuned technological innovation. Linking quantum R&D to societal goals—such as the UN Sustainable Development Goals (SDGs)—marks a welcome shift from purely military or commercial imperatives toward more socially engaged innovation. Furthermore, Q4G opens up opportunities to steer quantum research in the public interest.

However, Q4G's *technology-first* orientation raises concerns, as it shapes how problems and their solutions are identified. When quantum technologies are treated as prefigured solutions, social problems risk being reframed in narrow, technically tractable terms. This may obscure non-technological aspects of the issues, depoliticise (or 'technologise') inherently political and social questions, and marginalise more effective or ethically preferable alternatives. Moreover, given the early-stage nature of most quantum technologies and the uncertainties surrounding their development, claims about their value for urgent societal issues often rest on speculative assumptions, raising questions about whether quantum technologies can realistically be considered a plausible or appropriate solution.

Furthermore, the innovation ecosystem promoted under Q4G is not clearly separable from commercial or strategic agendas. In the absence of transparent and socially grounded success criteria, Q4G risks becoming a legitimising narrative for 'quantum for profit' or 'quantum for competitiveness'; while quantum's potential scientific, economic, and geopolitical gains are, in turn, mobilised to legitimise the pursuit of societal gains, creating a mutually reinforcing dynamic. There is nothing inherently wrong with pursuing economic or strategic goals, but these should not be conflated with the pursuit of the public good, and not taken to lend credibility when practical applications in these domains

remain absent. For Q4G to go beyond rhetorical alignment with public good (e.g. the SDGs), it must engage with the sociopolitical, ethical, and institutional conditions for real-world impact, and not treat these as externalities.

Thus, in order for Q4G to fulfil its promise and avoid becoming a mere legitimising narrative for existing innovation agendas, it must engage with the limits of technological fixes, recognise the social, ethical, and political dimensions of societal challenges, and invite debate on the role of quantum technologies in society. Only by politicising—not depoliticising—the challenges it seeks to address can Q4G move from symbolic ambition, or worse, a normative façade, to meaningful public good (cf. Shelley-Egan, 2025). Here lies an important task for the research community, particularly for researchers focusing on the ethical, legal, social aspects of technological development and deployment. However, critical scrutiny of technosolutionist initiatives extends beyond academia; the guidelines outlined in this paper may also be integrated into broader technology assessment approaches.

To conclude, our aim has not been to dismiss Q4G for its technosolutionist tendencies. Rather, by drawing attention to these tendencies, we highlight the risks embedded in current framings and practices of Q4G. Framing Q4G as a form of technosolutionism is intended not as rejection but as an analytic tool to invite critical reflection within the field. Such scrutiny, we suggest, can support the development of a more ethically robust paradigm. The guiding questions we propose offer a means to identify ethical issues early in the design of technological interventions—quantum or otherwise—and to address morally problematic forms of technosolutionism upfront.

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CRedit authorship contribution statement

Eline de Jong: Writing – review & editing, Writing – original draft, Investigation. **Clare Shelley-Egan:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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