Bridging Ethics and Institutions: Embedding Care in Gender-Focused Technology and STEM Reform[1]

Fernando Miramontes Forattini[2]
Dublin City University

Regina Connolly
Dublin City University

Abstract

This paper argues that ethical technology design cannot be meaningfully addressed without transforming the institutional gender regimes that shape the science, technology, engineering, and mathematics (STEM) ecosystem. Drawing on care ethics and institutional gender theory, it develops an integrated framework for examining both the normative assumptions embedded in technology and the organizational conditions under which it is produced. Through a narrative review of gender-focused technology design and a cross-case synthesis of empirical studies on care ethics in practice, the paper shows how gender stereotypes, role congruity expectations, and ideal-worker norms constrain participation, leadership, and the ethical content of design itself. It critiques dominant ethical paradigms, particularly utilitarian and deontological approaches, for marginalizing the embodied, relational, and contextual dimensions of excluded groups' lived experience. In response, the paper advances care ethics as a generative framework that must be institutionally embedded if it is to challenge technocratic neutrality and support more inclusive design and policy practices. Rather than presenting care ethics as a self-contained solution, the paper positions it as a critical lens for rethinking both technological design and institutional reform, thereby contributing to more just, accountable, and socially responsive technological futures.

Keywords: Gender-focused technology, Institutional theory; Care ethics; Feminist institutionalism; STEM reform.

1. Introduction

Technology's pervasive influence in society drives transformative changes across governance, economic systems, and cultural practices. It enables new forms of connectivity, empowers communities, and accelerates innovation. Yet this transformative potential is double-edged. As information technologies become embedded in everyday life, they often deepen socio-economic divides and reinforce longstanding social hierarchies, particularly gender inequalities, one of the most visible and persistent axes of exclusion (Sharma et al., 2021). In a world increasingly shaped by techno-culture, a socio-material condition in which technological advancement both reflects and structures dominant norms, technology functions not as a neutral tool, but as an agent of power that reproduces institutional logics and cultural values (Hui, 2019; Hilbert, 2014).

The gendered nature of this reproduction is frequently underestimated. Designed, financed, and implemented within structurally unequal institutions, technologies often inherit not only the epistemologies of their designers but also the exclusions embedded in those institutions (Winner, 2010). These dynamics have become more acute amid a global backlash against gender justice initiatives. In many countries, feminist frameworks are increasingly framed as ideological threats to neutrality, meritocracy, or institutional legitimacy (Biroli & Caminotti, 2020; Cupać & Ebetürk, 2020). This erosion of support has direct implications for gender-focused technology design, not only via policy rollbacks and funding cuts but also by

[1] This is the Author Accepted Manuscript of an article accepted for publication in ACM SIGMIS Database: the DATABASE for Advances in Information Systems. The Version of Record will be published by ACM in the ACM Digital Library. DOI to be added when available.

[2] This publication has emanated from research jointly funded by Taighde Éireann – Research Ireland under Grant Number 13/RC/2094_2, and co-funded by the European Union under the Systems, Methods, Context (SyMeCo) programme Grant Agreement Number 101081459. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

delegitimizing the ethical frameworks on which inclusive design depends.

This climate of institutional retrenchment and cultural backlash coincides with an intensification of technical abstraction in design practices. Many gender-responsive technologies – ranging from safety apps to platforms for civic participation – suffer from low adoption and limited contextual sensitivity. These shortcomings are often interpreted as implementation failures or user disengagement. Yet, such outcomes point to deeper limitations in the frameworks guiding technology design.

Dominant ethical paradigms in the Information Systems (IS) field – particularly utilitarian and deontological models – privilege abstraction, neutrality, and individual autonomy. As a result, they struggle to account for the relational, embodied, and context-sensitive nature of gendered experience (Feeney & Fusi, 2021). These ethical paradigms erase the complexity of interdependence and care, particularly for marginalized users whose needs and knowledge are often excluded from the early stages of design. Structural barriers – such as the absence of more contextual and inclusive ethical frameworks and the persistent underrepresentation of women in technical courses, leadership roles, and design processes – further hinder meaningful participation and contextual alignment (Holtzblatt & Marsden, 2018). These exclusions are not merely demographic but are *symptomatic of broader institutional logics* that render care-oriented knowledge peripheral to dominant models of technological legitimacy.

In response, care ethics has emerged as a promising alternative. Rooted in feminist moral philosophy, care ethics centers relationality, vulnerability, and moral responsibility within situated contexts. However, its application in tech design faces multiple hurdles. Beyond conceptual debates – such as critiques of vagueness, gender essentialism, or caregiver dependency dynamics – care ethics often fails to achieve institutional traction. It is adopted in superficial or tokenistic ways, stripped of its structural critique and reduced to a user-centered add-on. Moreover, care-oriented design encounters practical resistance in STEM and technology sectors marked by competitive individualism, lead user bias, developer-user asymmetries, and market-driven priorities.

These tensions highlight that care ethics, when confined to the design phase, cannot meaningfully challenge the broader institutional conditions that shape how technologies are conceived, who participates in their development, and whose values are encoded within them. The persistent underrepresentation of women in STEM fields and leadership positions – alongside motherhood penalties, pay inequities, and inflexible career structures – limits not only access but the capacity to reshape dominant epistemologies. As gender theorists have shown, institutions are not neutral spaces. Rather, they are structured by gendered norms and expectations, including the valorization of the "ideal worker" as a disembodied, always-available subject unencumbered by caregiving responsibilities (Acker, 1990; Williams et al., 2012). These norms not only sustain material inequalities but also inhibit the adoption of ethical paradigms, such as care, that foreground interdependence and social responsibility.

Theories such as role congruity (Eagly & Karau, 2002) offer further insight into how women in STEM face not only structural but also symbolic barriers. Leadership and technical authority are often coded as masculine traits, rendering women's presence and leadership style incongruent with organizational expectations. As a result, efforts to integrate care ethics into design processes can be dismissed as soft, emotional, or incompatible with scientific objectivity. The friction between care-based values and technocratic institutional cultures reveals that ethical frameworks in tech design and transformation must proceed hand-in-hand with institutional reform.

This paper advances the argument *that ethical technology design cannot be meaningfully addressed without transforming the institutional gender regimes of STEM*. We contend that care ethics is not a stand-alone solution but a critical starting point – a lens that enables the reframing of both design values and institutional conditions. By bridging care ethics with institutional gender theory, we offer an integrated approach that reconfigures ethical inquiry as a constitutive, rather than supplemental, component of technological innovation. This approach positions care not merely as a principle of interpersonal design but as an organizational and policy imperative – one capable of restructuring how problems are defined, how accountability is distributed, and whose experiences are deemed central in the technological imagination.

This paper begins by contextualizing the political and institutional backlash facing gender-inclusive technology design, emphasizing the erosion of support for feminist and equity-oriented frameworks in STEM. It then addresses the structural barriers and gender stereotypes that shape these fields, drawing on institutional gender theory to analyze the marginalization of care-oriented approaches. Building on this, the paper offers a critical analysis of dominant ethical paradigms in technology design, utilitarianism, deontology, and virtue ethics, demonstrating their limitations in confronting gendered exclusion. The discussion then turns to care ethics, outlining its foundational principles, normative contributions, and key critiques. We connect care ethics with institutional

gender theory, using the Athena SWAN initiative and national policy frameworks as illustrative cases of care-oriented institutional reform. This is followed by an examination of the application of care ethics in technology design across 40 empirical case studies, highlighting both enabling practices and structural constraints. The paper concludes by reflecting on the relationship between institutional structures and design practices, offering recommendations for embedding care ethics into the epistemic and organizational logics of STEM.

2. Gender and Technology

While feminist principles have gained considerable traction within academic discourse and international policy frameworks, their application within the technological sector has faced escalating resistance. This pushback, championed by political leaders such as Vladimir Putin, Jair Bolsonaro, and Donald Trump, is part of a broader societal trend that amplifies anti-feminist rhetoric. Recent research shows that acceptance of gender initiatives and theories is steadily declining, with opinions divided on whether the push for gender equality has gone too far (Campbell et al., 2024). These political figures leverage such sentiments, portraying gender equality as a value system championed by a minority elite (Corredor, 2019) that has overreached its demands and appropriated "society's main institutions" (Kuhar & Paternotte, 2017). For them, these initiatives are immoral, illegal, and a blight on society, "compelling" them to act as "moral actors" against its development (Kalm & Meeuwisse, 2023).

Interestingly, these agents heavily rely on technology to engage with their constituents (Dojčinović & Ljajić, 2022), leading to the prioritization of these technologies as tools for conservative activism. Technologies that once promised to amplify voices of marginalized groups are co-opted for disseminating misinformation and hate speech, specifically for gender violence (Bürger et al., 2020). Fully aware of the role technology plays in shaping public opinion, these groups have moved to influence its development and regulatory frameworks, actively pressuring platforms and institutions to defund or dismantle gender-inclusive projects.

The technological sector cannot be understood apart from this broader backlash. Recent public interventions by prominent figures in the tech industry have treated the removal of Harvard President Claudine Gay and the retrenchment of Diversity, Equity, and Inclusion (DEI) initiatives as signs of a wider shift against gender- and equity-oriented institutional reforms (Zeff, 2024). Framed in this way, inclusion efforts are recast as threats to meritocracy, neutrality, or legal fairness rather than as attempts to address entrenched structural inequality.

Read analytically, these interventions are significant not because they are exceptional, but because they exemplify a broader discursive pattern in which claims about fairness, neutrality, and institutional overreach are mobilized to contest gender-focused initiatives. In the technological sector, such discourse matters because the institutions from which technologies emerge, including firms, funding bodies, and academic laboratories, continue to be shaped by historically masculinized value systems. As a result, resistance to gender-inclusive initiatives is not external to technological development; it forms part of the environment in which technologies are conceived, evaluated, and legitimized.

Recent organizational decisions reinforce this point. Meta and Google have publicly scaled back DEI commitments while citing changing legal and political conditions, illustrating how broader ideological and regulatory pressures can be translated into corporate policy (Allen & Fischer, 2025; AP News, 2025). Similarly, MIT's closure of its Community and Equity Office in 2025 can be read as part of a wider narrowing of institutional commitments to equity in higher education under intensifying political pressure (CNN, 2025; New York Post, 2025).

In this context, the marginalization of care-oriented and gender-inclusive approaches is not anomalous but structurally patterned. From gendered tracking in STEM education to the masculinization of engineering cultures and epistemic gatekeeping in innovation systems, exclusion has long shaped how technologies are conceived, funded, and validated. These dynamics extend beyond questions of representation. They influence what counts as innovation, whose needs are recognized as legitimate, and which ethical frameworks are treated as serious or actionable.

Seen in this light, the backlash against gender-inclusive initiatives also reveals the limits of ethical paradigms tethered to technocratic ideals of neutrality, abstraction, and efficiency. Frameworks grounded in care, interdependence, and relational responsibility are often dismissed not only because of ideological disagreement, but because they challenge entrenched institutional assumptions about value, legitimacy, and labor.

These dynamics extend beyond corporate and political spheres to academia and STEM disciplines, where material constraints (unequal pay, motherhood penalties, rigid tenure clocks) intersect with symbolic exclusions (role incongruity, masculine coding of authority). As Faulkner (2007) and Wajcman (2011) note, these exclusions are not peripheral but constitutive of dominant epistemologies that prioritize autonomy,

competition, and disembodied expertise. Within such logics, care is rendered either irrelevant or incompatible with technological rigor.

Bridging this gap requires more than ethical retooling at the level of design; it demands a structural reimagining of the institutions where technologies are developed, deployed, and legitimized. Ethical frameworks, in this sense, should not be seen as a conclusive solution to technological design, as current practices have shown, but as a starting point for rethinking how inclusion and responsibility are conceptualized across technological and institutional domains.

By positioning care ethics as both a normative and structural lens, this paper advances a dual strategy, one that integrates inclusive ethical reflection with systemic change. By repositioning ethics not as a reactive afterthought, but as a generative foundation, this paper aims to offer a new perspective on design and institutional questions such as which problems matter, whose voices count, and how accountability is built into technological practice from the outset.

3. Methodology

This study adopts a narrative literature review to examine how care ethics informs gender-focused technology design and the institutional conditions shaping it. This approach was selected as it enabled an interpretive synthesis across diverse theoretical, disciplinary, and empirical literatures.

Search Strategy and Data Collection: to develop our analytical corpus, we began by consulting existing literature to establish historical, theoretical, and conceptual baselines. We constructed a search vocabulary anchored in feminist theory, ethics of technology, and gender in STEM. Our initial focus on seminal works in technology design, ethical frameworks, and gender studies informed the broader database search, conducted primarily through the ACM Digital Library. Search terms included "technology design," "participatory design," and "gender technology," allowing for a wide-ranging but conceptually focused data pool. Early findings revealed that while many papers addressed gender and technology independently, few examined how ethical paradigms shape, and are shaped by, institutional structures. This gap guided the review strategy adopted in this paper.

Inclusion and Exclusion Criteria: we refined our search by incorporating concepts from major ethical theories, including "deontology," "utilitarianism," "virtue ethics," and "care ethics." This refinement reduced the corpus to 3,217 results. We then applied specific inclusion and exclusion criteria to narrow our focus. Studies were included if they addressed the integration of ethical frameworks within technology design, particularly in relation to gender, inclusion, or institutional context. Abstracts were screened first, and full texts were consulted when abstracts did not provide sufficient detail. Studies were excluded if they did not engage technology design in a substantive way or discussed technology without a discernible ethical framework. This process resulted in a final corpus of 308 papers published between 2010 and 2023.

Data Extraction and Analysis: from the final corpus, we conducted a second-stage purposive selection to identify studies examining care ethics in practice, particularly where it intersected with gender and institutional context. We prioritized case-based studies that enabled closer analysis of how care ethics was understood, applied, and problematized in concrete settings. This process resulted in a subset of 40 case studies, which were coded qualitatively in Excel across parameters including technology sector, target group, study objective, theoretical background and how care ethics was conceptualized, methodology, and the theoretical and practical limitations identified by the authors. Coding was conducted iteratively to refine the analytical categories and maintain consistency across cases.

Synthesis of Findings: after coding, we conducted a cross-case thematic synthesis of the 40 studies to identify recurring patterns in how care ethics was incorporated into design processes, where implementation frictions emerged, and how gender and institutional context shaped uptake, sustainability, and exclusion. This stage moved beyond the description of individual studies and focused on patterns recurring across sectors including healthcare, education, nanotechnology, and computer science. This synthesis informed our broader argument about the conditions under which care ethics can be enacted, constrained, or absorbed within gendered institutional settings.

Integrating Institutional Perspectives: to move beyond a narrow focus on ethics in design, we complemented the narrative review with institutional perspectives. Connolly and Richardson's (2023) reflexive case study provided methodological insight into how inclusivity efforts are embedded, negotiated, and reshaped within gendered institutional settings. Their analysis of policy discourse, organizational routines, and institutional tensions helped bridge care ethics and institutional theory. This strengthened our analysis by situating ethical design within the organizational and policy contexts through which it is interpreted and implemented, allowing us to examine how care operates within existing institutional arrangements and how structural conditions shape the prospects for meaningful reform.

4. Rethinking Ethical Frameworks

Mainstream technology design – particularly in gender-focused domains – continues to be shaped by traditional ethical frameworks such as utilitarianism, deontology, and virtue ethics. These paradigms, rooted in Enlightenment ideals of rationality and autonomy, tend to privilege universal standards, impartial reasoning, and individual decision-making. While these principles have long structured debates in moral philosophy, they also reflect the epistemic and organizational cultures of STEM fields.

This alignment is not coincidental. As feminist scholars have noted (Faulkner, 2007; Wajcman, 2011), the dominance of these frameworks is reinforced by the institutional logics of the very environments in which they are applied. In design labs, research departments, and corporate tech hubs, ethical reasoning does not occur in a vacuum. It is shaped by ideologies, norms, funding incentives, and gendered expectations that prioritize technical efficiency over moral complexity. In this context, the persistence of utilitarian and deontological reasoning is not merely a theoretical preference, it reflects and reproduces a broader institutional order that marginalizes relational forms of knowing and devalues care as a design principle.

Our review of 308 selected papers confirmed this structural dominance: utilitarianism appeared in 46.6% of studies, followed by deontology (24.0%), virtue ethics (16.4%), and care ethics (13.0%). This distribution reveals not only the marginality of care ethics within technology discourse, but also the extent to which ethical reflection in design remains tethered to frameworks that are ill-suited to the complexities of social difference and vulnerability. Without addressing the gendered institutions that legitimize these frameworks, attempts to reform tech ethics risk becoming isolated, well-intentioned but structurally disempowered.

In the following subsections, we revisit these dominant ethical paradigms, beginning with utilitarianism. We analyze their conceptual strengths and practical applications, while also highlighting their limitations, particularly their complicity in reinforcing gendered exclusions, both in technology design and in the professional cultures that authorize it.

4.1. Utilitarianism: Balancing Utility and Justice

Utilitarian ethics focuses on the consequences of actions rather than their intrinsic qualities, aiming to achieve the greatest good for the greatest number. Grounded in the work of Jeremy Bentham and John Stuart Mill, utilitarianism has had a lasting influence in moral philosophy, economics, and public policy (Scheffler, 1988). Over time, variations such as Popper's (1945) "negative utilitarianism," which emphasizes the minimization of suffering, and Harsanyi's (1977) "preference utilitarianism," which distinguishes between impulsive desires and rational choices, have emerged in response to the framework's limitations.

In the technological sector, utilitarian logic is frequently employed in design decisions, product evaluation, and regulatory assessments (Floridi, 2016). From cost-benefit analyses to user experience testing, it provides a practical calculus for allocating resources and prioritizing outcomes. Prominent examples include NASA's Technology Leverage Factor and Technology Impact assessments (Terrile et al., 2014), as well as international guidelines for AI development and data governance (Franzke, 2022). These practices reflect utilitarianism's appeal to scalability, predictability, and neutrality, values deeply embedded in the epistemic culture of STEM.

However, this framework is not ethically neutral. Its aggregate orientation tends to sideline minority experiences and justify harms if they are outweighed by perceived collective benefits (Goodin, 1995). In machine learning and algorithmic design, utilitarian metrics such as efficiency and accuracy often mask racial and gender biases, producing outcomes that disproportionately disadvantage marginalized groups (Binns, 2018). The Cambridge Analytica scandal offers a paradigmatic example of how utilitarian logic, framed around maximizing electoral impact, can erode privacy and democratic accountability (Zuboff, 2023).

Moreover, utilitarianism's conceptual simplifications often align with dominant institutional interests. Its emphasis on quantification, neutrality, and optimization resonates strongly with the masculinized ideals of STEM cultures and tech entrepreneurship, which valorize abstraction, technical control, and competitive individualism (Faulkner, 2007; Wajcman, 2011). As such, utilitarianism functions not only as an ethical tool but also as a legitimating discourse that sustains hierarchical, exclusionary structures. It privileges perspectives already dominant in design teams, typically white, male, and elite, while casting relational, care-based concerns as soft or irrational.

In the context of gender-focused technologies, these blind spots are particularly acute. Utilitarian reasoning can obscure the ethical significance of affective labor, embodied vulnerability, and interpersonal accountability, dimensions critical to designing for inclusion. While utilitarianism may appear efficient or fair in abstract terms, its real-world application too often reinforces power asymmetries and marginalizes the groups that inclusive design seeks to

support. As such, any effort to transform ethical practices in technology must grapple not only with the limitations of utilitarian logic but also with the institutional ecosystems that allow it to dominate.

4.2. Deontology: Challenges of Inflexibility

Deontological ethics, grounded in the philosophy of Immanuel Kant, emphasizes the intrinsic morality of actions based on duties, obligations, and rights, rather than outcomes. This framework has long been influential in moral reasoning, legal doctrine, and public policy, where clarity, consistency, and universality are prioritized. In response to critiques of rigidity, contemporary deontology has evolved to accommodate more pluralistic interpretations. For instance, Ross (2002) introduced the idea of prima facie duties, multiple, context-sensitive obligations that can be weighed against one another, while Scanlon (2000) advocated contractualist approaches that attend to justifiability to others. These developments have made deontology more responsive to moral complexity without abandoning its core commitment to rule-based ethics.

In the technological sector, deontological reasoning plays a central role in shaping professional codes of conduct, regulatory frameworks, and institutional accountability mechanisms. Principles such as the right to privacy, the obligation to secure user data, and the duty to prevent harm are encoded in various guidelines for AI development and digital governance (Floridi & Taddeo, 2016). For instance, deontological logic underpins GDPR's emphasis on consent and user rights, as well as corporate ethics programs that mandate compliance with rules irrespective of cost or convenience (Brey, 2012). Advocates contend that this framework offers clear boundaries for action in high-stakes, fast-evolving domains, especially when discretionary judgment may be influenced by market incentives or social bias.

Yet, despite these strengths, deontology faces substantial challenges when applied to gender-focused technology. Its emphasis on universal duties often masks the situated and relational dimensions of ethical engagement, leading to frameworks that appear fair in abstraction but fail to address social asymmetries in practice. Rigid adherence to rules may sideline the needs of marginalized groups, particularly when those rules are designed from a majority perspective and lack mechanisms for incorporating lived experience or iterative feedback (Crosby & VanDeVeer, 2000). When "treating everyone equally" becomes a mantra divorced from structural context, the result is often not fairness but further marginalization.

These limitations are compounded in institutional environments where hierarchical norms and standardization dominate. In STEM workplaces, deontological ethics often aligns with bureaucratic rationality and hierarchical command structures, reinforcing cultures that value rule-following over reflexivity. As Acker (1990) and Wajcman (2011) have shown, such environments privilege impersonal, disembodied ideals of the "ideal worker," thereby rendering care, relational judgment, and context-specific adaptation secondary or even suspect. In these settings, deontological ethics can inadvertently fortify the very power asymmetries that inclusive design seeks to redress by delegitimizing context-sensitive ethical reasoning in favor of abstract and procedural compliance.

Consequently, while deontology can provide essential protections, especially where clear boundaries are necessary, it is insufficient on its own. For gender-responsive technology and institutional transformation alike, ethical frameworks must not only articulate duties but also attend to the embodied, relational, and power-laden contexts in which those duties are enacted. Without such attentiveness, deontological ethics risks reifying exclusion under the guise of neutrality.

4.3. Virtue Ethics: Universal Values and Individualism

Virtue ethics, a tradition that emphasizes the cultivation of moral character and the kind of person one ought to become, has experienced a resurgence after a long period of academic marginalization (Annas, 2003; Hursthouse, 1999). Unlike consequentialist or deontological theories, virtue ethics focuses not on specific actions or duties, but on traits such as courage, honesty, and empathy as guides for ethical behavior. This revival has extended into applied fields, including technology and AI ethics, where scholars such as Vallor (2016) advocated for frameworks grounded in classical philosophical traditions. Vallor's model proposes a globally applicable set of virtues derived from Aristotelian, Confucian, and Buddhist ethics, arguing for their relevance in shaping "technomoral" character amidst rapid technological change.

However, this aspiration toward universalism has drawn substantial critique. The construction of a standardized virtue set, often implicitly male-coded and abstracted from socio-historical realities, risks reproducing dominant moral norms while marginalizing others (Swanton, 2003; Slote, 1993). These frameworks frequently rely on idealized conceptions of human nature without adequately justifying their normative content across cultural and institutional contexts. In technological development, such abstractions can

obscure the situated realities of those excluded from dominant narratives of virtue, reinforcing rather than challenging epistemic and structural inequality. For instance, when virtues like "courage" or "resilience" are valorized without attention to the conditions under which individuals are expected to perform them, they can naturalize demands for self-sacrifice from already overburdened groups – particularly women and caregivers in STEM and tech workplaces.

Critics have also pointed to the vagueness of virtue ethics, particularly its lack of clarity regarding the selection, prioritization, and contextual application of virtues (Annas, 2003; Slote, 1993). This ambiguity leaves virtue ethics vulnerable to subjective interpretation and inconsistent implementation, especially in complex organizational settings. While some virtue ethicists attempt to counter charges of individualism by emphasizing relational traits like empathy or civility, these are often framed as personal attributes rather than outcomes of structural and institutional cultivation. As MacIntyre (2007) argues, virtues are socially embedded and historically shaped; their development is inseparable from the communal and institutional environments in which individuals live and work.

Yet, mainstream virtue ethics has largely failed to interrogate the institutional logics that condition which virtues are valued, by whom, and to what ends. This omission is particularly problematic in STEM fields and tech sectors, where the dominant moral order often privileges competitiveness, autonomy, and dispassionate objectivity. Such cultures obscure the relational labor involved in collaboration, care, and ethical reflection. Without a robust account of institutional power and normative structuring, virtue ethics risks reinforcing the very gendered hierarchies it ought to question. As Slote (1993, p. 5) notes, virtue ethics has a "proven record of siding with anti-democratic social/political ideals," raising concerns about its susceptibility to conservative co-optation.

Thus, while virtue ethics offers interesting tools for thinking about character and moral motivation, its insufficient attention to structural inequalities and institutional reproduction limits its capacity to support inclusive and socially just technology design. To be effective in contemporary socio-technical environments, ethical frameworks must not only ask who we ought to be, but also who gets to decide, under what conditions, and with what consequences.

5. Reframing Ethics Through Care: A Contextual and Institutional Turn

This section examines care ethics not merely as a counterpoint to dominant moral theories, but as a catalyst for reimagining both technology design and the institutional structures that govern it. Rooted in feminist philosophy, care ethics prioritizes interdependence, situated knowledge, and relational responsibility. Rather than prescribing abstract moral principles or utilitarian calculations, it foregrounds the ethical significance of attending to specific needs within real social contexts. Such an approach demands sensitivity to power disparities and structural exclusions, particularly those embedded in the design, deployment, and governance of technologies.

We begin by outlining the foundational tenets of care ethics and its divergence from universalist approaches that dominate ethical deliberation in technology development. We then engage with major criticisms of care ethics, such as its association with private sphere values, emotional burden, or conceptual vagueness, not to dismiss them, but to demonstrate how they surface key tensions and opportunities for ethical refinement. In doing so, we frame care not only as an alternative moral stance but as a transformative practice, one capable of realigning both technological processes and institutional arrangements toward more inclusive and responsive outcomes.

The section concludes with empirical findings from 40 case studies, illustrating how care ethics has been applied in diverse design contexts, from AI to assistive technologies, while also identifying the institutional barriers that often limit its uptake. By foregrounding care ethics as both a normative and organizational tool, we argue for a dual strategy: ethical design grounded in relational principles must be matched by institutional environments capable of sustaining those commitments. One cannot function effectively without the other.

5.1. What is Care Ethics?

Care ethics can be broadly conceptualized as an ethical framework rooted in the feminist philosophical tradition that emphasizes the importance of relational and contextual morality (Gilligan, 1993). Instead of focusing on universal principles or the greatest good for the greatest number, care ethics centers on human relationships and the moral significance of caring, highlighting the imperative to respond to the needs of specific individuals within their social and unique contexts (Tronto, 1993; Noddings, 1984). It challenges the individualism inherent in traditional models by promoting a relational and context-dependent morality. It rejects abstract perspectives of ethics or virtues detached from society, acknowledging power imbalances and how it can shape values and rules, and the vulnerability in human life (Engster, 2019).

Care ethics demands a transdisciplinary approach, socially and culturally rooted (Held, 2006). Its broader

implications extend beyond individual relationships, serving as a foundation for addressing political and social justice concerns (Tronto, 1993). This framework involves caring relationships and understanding those relationships within broader social structures, providing a critical lens for examining social inequalities. By emphasizing relationality and the moral significance of care, it offers a deeply attuned understanding of moral responsibility, recognizing individual and community experiences while avoiding homogenizing outcomes.

As a normative stance, care ethics recognizes that ethical judgment must be attentive to asymmetries of power, histories of exclusion, and culturally specific understandings of well-being. It is thus not only a moral orientation but a critique of abstract, individualistic, and procedural ethical models that dominate Western moral philosophy and governance. Virginia Held (2006) argues that care should be seen as a central moral value and political principle, with relevance far beyond interpersonal settings. In this view, care is not simply an affective disposition, but a socio-political practice capable of reshaping institutions, policies, and collective responsibilities.

This dual orientation, toward both intimate relationships and institutional architectures, renders care ethics particularly salient for rethinking the nexus between technology design and STEM environments. It challenges the instrumental rationality and meritocratic ideals that undergird many innovation processes, exposing how dominant values of efficiency, objectivity, and autonomy often marginalize emotional labor, social accountability, and alternative epistemologies. As Wajcman (2011) notes, what is presented as "neutral" or "rational" in algorithmic systems is frequently imbued with masculine-coded assumptions. In this context, care ethics offers a critical and constructive framework for centering lived experience, participatory engagement, and contextual responsiveness in technological development.

Care ethics has also found growing application across diverse domains, including education (Noddings, 1984), healthcare (Engster, 2007), environmental ethics (Donovan & Adams, 2007), and the development of emerging technologies. For example, Nurock (2021) explores how care ethics can inform responsible nanotechnology design by promoting empathy and attentiveness to the social impacts of innovation. Tronto (1993) similarly extends care to political and ecological relations, proposing an ethic of care capable of guiding democratic governance and long-term planetary stewardship.

In the context of STEM institutions and design cultures, this implies that care must be more than an auxiliary or downstream ethical consideration. It must be embedded in the epistemic and organizational foundations that shape which problems are addressed, whose voices are legitimized, and how futures are imagined. This reframing is not a call for sentimentalism, but for an ethical reorientation that aligns technological and institutional practices with the relational and interdependent nature of human life.

5.2. Addressing Criticism and Exploring Potentials

Addressing the criticisms of care ethics is essential not only for clarifying its theoretical contours but also for refining its practical application in technology design and STEM governance. These critiques, often overlooked in technological discourses, offer valuable insights that can strengthen care ethics as a framework for developing more inclusive and responsive systems.

Traditional Roles, Private Sphere Constraints, and Emotional Toll: a pungent criticism of care ethics comes from Sandra Lee Bartky (1990), who argues that care ethics can reinforce traditional gender stereotypes and roles. Tronto (1993) amplifies this critique, emphasizing that the role of care should not be seen as something natural or instinctive to women but as a critical moral framework of all humans. Historically confined to women by patriarchal societies, the association of care exclusively with women reinforces existing power structures, isolating women from decision-making roles and limiting care's applicability to broader moral and political debates. Tronto (1993) encourages for including care ethics within public and political spheres, rather than confining it to private, domestic roles. By framing care as a political ideal, she argues that it encompasses qualities necessary for democratic citizenship, such as attentiveness, responsibility, competence, and responsiveness. Thus, care becomes a tool for analysis, revealing relationships of power and privilege while offering a strategy for empowerment. This perspective shifts the debate from an individualistic perspective to a communal, highlighting existing inequities and providing a basis for change. It allows for a more inclusive and democratic approach, incorporating women and other traditionally excluded groups as actors.

Bartky (1990) emphasizes that although valuing emotional labor aims to elevate women's status, it can sometimes overlook the potential harm women may endure through this labor. She criticizes feminist theorists who celebrate female nurturance without critically analyzing the pitfalls of caregiving itself. This critique is supported by empirical evidence in tech design case studies, which highlight the challenges of engaging with others through care when designing technology. For instance, Spiel et al. (2018) discusses the complexities of applying care ethics in participatory

design, particularly the challenge of balancing professional and personal conduct in the context of vulnerable researchers and marginalized communities. They describe the discomfort that arises from navigating ethical boundaries, the risks of over-planning, and the need for adaptability and safety measures. The study also notes that decisions, such as overriding initial refusals based on perceived benefits, can unintentionally cause harm. Spiel et al. (2018) underscores the importance of balancing partnership and care, asserting authority when necessary, and maintaining transparency, all while being mindful of the influence of researchers' gender expressions.

I propose that Bartky's (1990) critiques should be understood not merely as a potential issue, as dealt with in case studies, but as inherent aspects of care ethics that should be accounted for and that can be leveraged for positive change. By recognizing the universality of care ethics while acknowledging its potential moral and emotional toll associated with its application, any ethical framework that uses care ethics must expand to include mechanisms for supporting every individual not just the focus group. This perspective transforms the critique into an opportunity to develop care further, integrating safeguards and support systems that mitigate what unpredictable challenges were involving any tech design, making them even more inclusive and effective.

Dependency and Power Imbalances: another significant concern with care ethics is its association with dependency, which critics argue can perpetuate power imbalances and reinforce notions of vulnerable dependence. Peter Allmark (1995) contends that care ethics' focus on the carer's intentions can lead to subjective caring that may not prevent harm, potentially resulting in paternalistic and controlling behavior. Helga Kuhse (1997) adds that good intentions in care can overshadow the autonomy and preferences of the cared-for, creating an imbalance where the caregiver's perspective becomes oppressive. This inherent power differential underscores that ethical care requires more than good intentions; it must also consider outcomes and ensure that it supports the autonomy and empowerment of cared-for individuals.

Kittay (2011) offers a nuanced perspective that reinterprets these criticisms. She argues that dependency is a natural part of human life and not inherently negative. Recognizing dependency as a shared human condition can promote empathy and the development of supportive social structures. Kittay (2011) emphasizes that dependency is shaped by broader economic, political, and social forces, and that understanding these factors is crucial for addressing power imbalances in caregiving relationships. By valuing care labor and recognizing its essential role, care ethics can challenge oppressive attitudes and reduce the stigma of dependency, an overwhelming feeling in an individualistic and competitive society. This promotes a more inclusive and compassionate society.

Reframing dependency as a fundamental aspect of human existence rather than a limitation advocates a reevaluation of societal norms that prioritize independence. Care should be viewed as a valuable resource for a fulfilling life, affecting communities, public policy, resource gaps, and tech development. This perspective shifts the user-tech relationship towards a more collaborative and reciprocal model rather than one that is individualistic or exploitative.

Is care too abstract and broad a concept? A practical approach: care ethics is sometimes criticized for vagueness and a lack of robust theoretical foundation. Critics argue that care ethics is associated with values from virtue ethics, like attentiveness and responsibility, without providing a solid framework for substantial moral judgments. This misinterpretation overlooks the relational nature of care ethics, which involves multiple agents in practice rather than individuals striving to perfect their moral capacities (Leget et al., 2019). Such reductionism risks turning care ethics into a subsection of value propositions arbitrarily applied across contexts. This ambiguity often leads to misunderstandings, confining care ethics to sectors like healthcare and nursing ethics, ignoring its broader applicability.

To address these critiques, it is essential to expand our theoretical understanding within political and institutional contexts. Care ethics inherently involves analyzing conflicts such as differing needs, the balance between self-care and care for others, and power inequalities. It is both culturally specific and universal, reflecting varied constructions of adequate care. Therefore, it should be viewed not merely as an individualistic or dyadic relationship but as a social and political practice. Without comprehensive training, there is a risk that care ethics will be inconsistently or superficially applied, undermining its potential benefits. To mitigate these challenges, it is crucial to develop adaptive ethical guidelines, invest in thorough training programs, and encourage collaborative design processes involving diverse stakeholders. This approach ensures that the relational and contextual nuances of care ethics are effectively integrated into technology design.

Despite being central to human life, care is ideologically marginalized, challenging societal power structures and necessitating a rethinking of moral and political life. Leget et al. (2019) suggest reframing care ethics to better capture its interdisciplinary nature and societal relevance. Viewing care ethics through the lens of "moral ecology" implies that moral practices are formed by normative expectations, negotiated responsibilities, and the lived realities of those involved

in caring relationships. This perspective shifts the focus from abstract theorizing to understanding morality via actual practices, relationships, and contexts. Walker's (2007) assertion that "morality itself consists of practices, not theories" reinforces this view, emphasizing that ethical thinking and actions should be grounded in real-world experiences.

Institutional Dimensions of Care: while care ethics has often been applied to interpersonal or team-level interactions in design contexts, its principles also raise critical questions for institutional reform. Specifically, care ethics challenges the technocratic and depersonalized logics that govern public institutions and STEM organizations, logics that measure accountability through audit regimes, standardized metrics, and procedural compliance, often at the expense of relational and ethical nuance.

Organizational structures rooted in formal, economic rationality are fundamentally misaligned with the relational values central to care. As Bergeron (2016) observes, dominant economic frameworks tend to "naturalize women's reproductive labor" and discount its value, rendering caregiving activities illegible within institutional accounting systems. These omissions are not incidental; they reflect a broader epistemic structure that devalues attentiveness, responsiveness, and contextual sensitivity, traits central to care ethics.

Montoya (2016) similarly critiques the procedural ethos of bureaucracies, tracing its lineage to Weberian ideals of impersonal governance. Such systems privilege abstract neutrality and rule-based legitimacy over embedded ethical practices, making it difficult to institutionalize values like empathy or care. Drawing on feminist institutionalism, she underscores how these organizational logics are not neutral but gendered, privileging masculine-coded behaviors and marginalizing relational forms of responsibility.

These critiques underscore a key tension: institutionalizing care ethics requires more than value alignment. It demands a deeper reckoning with how institutions are structured through gendered norms, performance regimes, and epistemic hierarchies. Without such structural transformation, even ethically motivated programs risk reinforcing the exclusions they seek to redress.

6. From Ethics to Institutions: Embedding Care in STEM Logics

Building on these critiques, it becomes crucial to address how care ethics might inform project-level design practices while also reshaping the institutional architectures of STEM. The meaningful institutionalization of care ethics in STEM environments necessitates more than the symbolic incorporation of ethical frameworks at project or team levels. It demands structural and epistemological shifts in how institutions recognize, reward, and embed relational values, such as empathy, responsiveness, and contextual judgment, in their core practices and metrics of accountability (Connell, 2019). The challenge lies in confronting entrenched logics of meritocracy, bureaucratic rationality, and abstraction, which often obscure the relational and gendered dimensions of institutional practices.

A salient example of this challenge is seen in the Athena SWAN (Scientific Women's Academic Network) initiative, initially designed to advance gender equality within higher education institutions (HEIs) by addressing gender bias and promoting inclusivity at multiple organizational levels.

In Ireland, the Athena SWAN program has expanded significantly, mandating gender equality assessments and action plans as prerequisites for institutional funding (Connolly & Richardson, 2023). While these measures have heightened institutional awareness and fostered explicit commitments to equality, the approach's procedural nature often limits deeper cultural change.

Critical evaluations of Athena SWAN's impact suggest that despite its progressive intent, institutional implementation often mirrors the technocratic tendencies it seeks to challenge. Connolly and Richardson (2023) highlight that Athena SWAN's reliance on quantifiable outcomes and standardized reporting can inadvertently perpetuate existing power imbalances. For example, much of the responsibility for achieving Athena SWAN objectives disproportionately falls upon women, thereby reinforcing gendered burdens, treating proposed solutions as isolated fixes, and hindering career progression (Caffrey et al., 2016; Ovseiko et al., 2017). Furthermore, institutional inertia and broader societal gender norms frequently dilute the initiative's transformative potential, relegating care-centered relationality to secondary concerns, subordinate to measurable outputs and formal compliance.

Care ethics could offer a critical framework for addressing these structural shortcomings by emphasizing relational accountability rather than procedural adherence. It calls for institutional environments where relational labor, often feminized, racialized, and invisible, is recognized and structurally supported (Tronto, 1993). Connolly and Richardson (2023) argue that effective implementation of care values in institutional frameworks necessitates reevaluating HR practices, performance metrics, and funding criteria that currently privilege individualistic, competitive, and output-driven outcomes. Institutional practices must explicitly recognize relational and

emotional labor as integral components of professional excellence and organizational success, transforming the terms of evaluation and reward beyond tokenistic diversity measures.

The need for systematic embedding of care ethics becomes especially acute in contexts where gender inequalities are compounded by institutionalized precarity. Research indicates that STEM workplaces regularly under-value collaborative activities, mentoring, and emotional labor integral to organizational health and innovation, activities which care ethics explicitly centers (Caffrey et al., 2016; Ovseiko et al., 2017). Hence, adopting care ethics within STEM requires *not only changes to formal policies but a fundamental reassessment of how institutional success is conceptualized, measured, and rewarded*. This approach aligns with the critique by feminist institutionalists that genuine equality initiatives must reconfigure organizational logics rather than merely adjusting them superficially (Bergeron, 2016; Montoya, 2016).

Further empirical studies underline this point. For instance, an Australian evaluation of Athena SWAN initiatives found that structural institutional changes were vital yet frequently superficial unless reinforced by deep cultural transformations within the institution and society at large (Ovseiko et al., 2017). Similarly, research from the University of Oxford revealed that although participants generally perceived positive structural and cultural changes from Athena SWAN participation, significant barriers persisted, including entrenched power dynamics, unequal workloads, and systemic undervaluation of relational labor (Ovseiko et al., 2017).

Care ethics thus provides a robust normative and practical framework for addressing these systemic deficiencies. Its relational orientation not only critiques prevailing institutional structures but also points toward a different institutional logic, one grounded in responsiveness, vulnerability, and shared responsibility. At the institutional level, this requires more than symbolic endorsement. It calls for governance practices, funding criteria, and evaluative mechanisms that treat relationality, contextual judgment, and affective labor as integral to organizational excellence rather than peripheral to it.

This approach has already been accomplished in adjacent sectors such as education and public research through targeted national policies that institutionalize care-oriented principles. For example, Finland's Early Childhood Education and Care (ECEC) framework integrates a contextual and relational educational system, bridging education, upbringing, and care as a unified right for all children, emphasizing care and learning as inseparable. Sweden's School-Age Educare (SAE) similarly mandates that "care, development and teaching constitute a whole," reflecting the relational ethos of care ethics in after-school educational practice (Haglund, 2019). In Latin America, Uruguay's pioneering 2015 National Integrated Care System (SNIC) institutionalizes care as a legal right and promotes "solidarity and co-responsibility of care" among state, families, and communities, with documented improvements in childcare enrolment and professional remuneration (Gailán et al., 2023).

In research governance, care ethics has also informed frameworks aimed at structural change. The EU's Responsible Research and Innovation (RRI) model embeds mutual responsiveness and inclusiveness as guiding principles for research agendas, demanding attentiveness to societal values and iterative stakeholder engagement, practices that resonate with care ethics (Stilgoe, Owen, & Macnaghten, 2013). Complementing this, King (2022) advocates a "culture of care" in research ethics, emphasizing support, responsiveness, and relational integrity over procedural compliance. Her analysis of UK research ethics committees demonstrates how institutional review processes can embody care by centering researcher-participant relationships and collegial support. Similar shifts are evident in participatory research ethics and national frameworks such as New Zealand's Te Ara Tika, which grounds Māori health research in principles of relational accountability and care for community ties (Health Research Council of New Zealand, 2019). Across these sectors, care ethics has increasingly been operationalized not as a rhetorical ideal but as a structuring logic, redirecting attention from individual performance to interdependence, contextual sensitivity, and institutional responsiveness.

For STEM institutions, these examples indicate more clearly what embedding care ethics would involve in practice. It would require rethinking how contribution is evaluated, how design processes are structured, and how accountability is defined. Mentoring, collaborative work, and affective labor would need to be recognized more explicitly within systems of evaluation and promotion, rather than remaining institutionally necessary yet professionally undervalued. Participatory and context-sensitive engagement would need to be built into design processes from the outset, instead of being confined to late-stage consultation. Funding, review, and governance arrangements would also need closer alignment with inclusion goals, so that responsiveness to marginalized groups becomes part of the criteria through which institutional success is assessed.

Ultimately, achieving the full promise of initiatives like Athena SWAN depends on integrating these care-ethical commitments into the structural core of STEM

institutions. Without corresponding changes in how contribution is evaluated, how design processes are organized, and how accountability is defined, institutional change remains vulnerable to compliance and tokenism. Even thoughtfully designed technologies grounded in care principles will then continue to face barriers in implementation and user adoption. This underscores the central argument of the article: institutional reform and technological design are interdependent, and meaningful change requires both to proceed in tandem.

In the following section, we address precisely these challenges, examining how care ethics has been operationalized within technology design practices, identifying specific issues, and exploring how institutional contexts shape the efficacy and sustainability of care-centered approaches in technological environments.

7. Real-World Tech Application Challenges

To fully realize the transformative potential of care ethics, institutional structure and design practice must be seen as mutually reinforcing. Our analysis of 40 empirical studies shows that even the most inclusive design methods can falter when embedded in technocratic, output-driven environments. Conversely, care-centered institutional logics can create enabling conditions for ethical design. Embedding care in STEM therefore requires a recursive alignment: structural reforms must inform design, and design must embody institutional commitments to care.

This dual demand reveals a critical fault line: care's socially and politically situated orientation remains one of its most contested and misunderstood dimensions, precisely because it challenges dominant paradigms of individualism and competition that obscure systemic inequalities and unlevelled starting points. Yet beyond ideological resistance or theoretical mischaracterization, our analysis of empirical case studies highlights both the *generative promise* and the *enduring obstacles* involved in applying care ethics to the design of technologies.

The following subsections offer an examination of the real-world challenges in applying care ethics to technology design, based on our analysis of 40 case studies from the 308 papers reviewed. These case studies cover sectors such as healthcare (30%), education (25%), nanotechnology (15%), AI and virtual reality (20%), and mobile health and assistive technologies (10%). The target groups included healthcare professionals (17.5%), technology designers and developers (30%), academics and researchers (20%), vulnerable and marginalized communities (22.5%), and specific user groups, including gig workers, elderly individuals, and disabled users (10%).

Grounded in specific findings, the discussions reflect the diverse theoretical frameworks that inform these studies, including feminist technoscience (25%), human-computer interaction (HCI) (40%), and science and technology studies (STS) (35%). These frameworks emphasize relationality, care, and the sociotechnical dynamics of power and gender.

In 68% of these studies, participatory design coupled with care ethics led to improvements in user satisfaction, technology adoption, and overall effectiveness. The remaining 32% conceded potential benefits but cited challenges in implementation due to institutional frameworks, resistance to change, and difficulty engaging with target groups.

Despite these positive outcomes, practical limitations emerged, highlighting the complexity of integrating care into technology design. These challenges can be grouped into three major categories: design issues (25%), contextual and social issues (35%), and ethical and practical challenges (40%).

Design Issues: one of the primary challenges in integrating care ethics into technology design is its inherent departure from the prevalent top-down approaches commonly used in the tech sector. These top-down approaches are characterized by centralized decision-making, often with minimal gender diversity and limited user involvement. While these methods are cost-effective and efficient, they frequently fail to capture the lived experiences and specific needs of diverse user groups, resulting in technologies that are less inclusive and less effective in the long term (Grates et al., 2019). Research indicates that these technologies typically have a short shelf-life due to the lack of user participation and appropriation, as users are aware of problems with existing technology. Conversely, participatory design approaches, especially when coupled with care ethics, actively involve users in the design process, ensuring that their voices and experiences shape the technology design. When technology is developed through this method, users overwhelmingly associate their experience with feelings of empowerment (Wilkinson & De Angeli, 2014).

Another significant issue is the reliance on lead users. For instance, Wilkinson & De Angeli (2014) showed how using care ethics could introduce lead user bias. The reliance on a specific group of users can skew results and fail to represent the broader user base, especially those with differing abilities or experiences. Similarly, studies using non-representative samples, such as university students, can limit the applicability and transferability of findings (Abu-Shanab & Al-Jamal, 2015). This challenge surfaces the issue of

scalability, as personal and context-specific ethics are usually difficult to scale, causing implementation issues for large-scale technologies for diverse populations.

Finally, Mendez et al. (2017) highlight that while this approach enhances transparency, understanding, and trust, it also increases complexity and clutter for both developers and users. This added complexity makes the task more laborious, as it requires manipulating individual data values which can potentially discourage exploration and iteration.

Contextual and Social Issues: engaging with vulnerable communities requires a deep understanding of their specific needs and contexts, which care ethics advocates for through its focus on empathy and relational morality. However, the practical challenges of maintaining long-term engagement and balancing workloads, as highlighted in Braybrooke et al. (2021), demonstrate that while care ethics provides a valuable framework, it requires significant resources and commitment to implement effectively. This underscores the need for adaptable frameworks that can be customized to fit different cultural contexts without losing the core principles of care ethics.

The effectiveness of ethical frameworks can vary widely due to cultural differences and local practices. Sambasivan et al. (2017) emphasize the challenges posed by regional cultural variances in their study on gender equity in technologies for the Global South. As Botez (2000) points out when considering implementing care in the health sector, what works in one cultural context may not be suitable for another, necessitating adaptable frameworks that consider these differences.

As mentioned as a theoretical issue of care, the emotional and psychological impacts on both researchers and participants are another significant concern. For example, Cochrane et al. (2022) noted that conducting first-person research requires the researcher to engage in emotionally triggering activities, potentially leading to distress if not managed carefully. This is particularly relevant in the development of technologies that must be initially tested by clients and users. While the first-person design researcher approach ensures methods are first assessed using the researchers' own bodies and emotional experiences, it raises questions about how much emotional labor can be ethically asked from participants. Additionally, the study highlighted how participants felt uncomfortable using the technology in public, underscoring the social consequences of publicly utilizing certain technology. This highlights another ethical concern: the reluctance and stigma participants face when using assistive technology, even when developed under a care framework, reflects broader social and institutional inequities in how disability and assistive technologies are valued and accommodated.

Ethical and practical challenges: the implementation of care ethics in tech design often encounters ethical dilemmas that cannot be fully addressed by broader ethical frameworks. The need for in-situ ethical judgments highlights the limitations of applying care ethics without an adaptable guideline that can address micro-ethical issues (Spiel et al., 2018). Moreover, the practicalities of ensuring transparency and balancing commercial interests with ethical considerations suggest that while care ethics offers a valuable perspective, it must be complemented by other ethical frameworks to navigate tech design.

Privacy and commercial sensitivities also play a crucial role. Studies often face restrictions due to commercial interests, limiting the sharing of detailed experimental findings and affecting research transparency. However, these studies consistently highlighted the transformative potential of participatory design, particularly when grounded in care ethics, to create functional and meaningful technology. Mendez et al. (2017) point out that while this approach enhances transparency and trust, it increases complexity, making the development and user interaction more laborious.

Addressing power dynamics within participatory design processes is critical. Ensuring true equity in participation and avoiding the replication of harmful hierarchies requires sensitive facilitation. Light & Akama (2014) discuss the difficulties in organizing and maintaining community engagement while balancing designer influence and participant autonomy in a distributed and heterogeneous socio-technical context. They recommend focusing on enabling participants to envision and enact their desired social structures, rather than prescribing specific outcomes.

8. Final Considerations

Care ethics, at its core, offers a fundamentally relational and context-sensitive approach to moral and political life. Emphasizing attentiveness, responsiveness, and interdependence, it departs from abstract, individualistic moral frameworks by grounding ethical responsibility in situated practices of mutual support. Though often associated with interpersonal domains, care ethics has emerged as a critical framework for interrogating broader systems of power, inequality, and exclusion, especially in technology design and institutional governance. This article has drawn on these principles to examine how care ethics can meaningfully reshape both the design of technologies and the structures within which such technologies are developed and deployed.

We have argued that the integration of care ethics into technology is not simply a matter of adding ethical guidelines to existing processes but demands a broader

structural transformation. Care is not a soft addition to innovation but a substantive challenge to the abstraction, neutrality, and detachment that have historically defined both technological development and STEM institutions. When fully embraced, care ethics redefines how problems are framed, whose knowledge is valued, and which forms of labor and judgment are rendered visible.

Through our engagement with feminist institutional theory and empirical studies on gender equity in STEM, particularly the case of Athena SWAN, we have shown that design-based interventions cannot be isolated from the institutional frameworks that shape their implementation. Initiatives nominally committed to inclusion often reproduce the very bureaucratic logics that marginalize relational values. As our analysis revealed, structural reforms must accompany ethical commitments if care is to be institutionalized not as compliance but as a guiding orientation for how institutions define legitimacy, success, and accountability.

At the same time, our synthesis of 40 care-aligned case studies demonstrates that applying care ethics in real-world design contexts involves a complex interplay of tensions and possibilities. Issues such as lead-user bias, challenges in cultural translation, emotional labor, and power asymmetries in participation illustrate that care is not a fixed template. Rather, it requires iterative negotiation, institutional support, and deep contextual sensitivity. These findings reaffirm that the effectiveness of care-based design is not determined solely by intent, but by the technical, cultural, and political infrastructures that enable or constrain ethical practice.

Nevertheless, critiques often raised against care ethics can be read more constructively. What is described as vagueness may instead reflect an ethical commitment to complexity and relational depth, while concerns over dependency point to the need to recognize interdependence and design for shared responsibility. Rather than treating care's flexibility as a weakness, it should be understood as an ethical strength that enables responsiveness to the cultural, social, and institutional textures in which technologies are embedded.

Importantly, these two domains of technology design and STEM institutions must not be seen as isolated spheres but as mutually constitutive. Institutional logics shape not only what is valued or funded in design processes, but also who participates, which knowledges are legitimized, and how care itself is defined. Conversely, design practices informed by care ethics, such as participatory methods, responsiveness to users, and inclusive epistemologies, can recursively challenge and reshape institutional assumptions about merit, innovation, and accountability. Recognizing this co-dependence is crucial: without institutional environments that recognize relational labor and complexity, care-centered design cannot thrive; without care-informed design, institutions risk reproducing the very exclusions they aim to redress.

Ultimately, this article has advanced a dual argument. First, care must be institutionalized, not through rigid formalization, but through a reconfiguration of the very purposes, values, and evaluative criteria that govern STEM institutions. Second, care must inform the design process itself, not simply by inviting participation, but by confronting the embedded assumptions about who technologies are for and how their value is defined. In both dimensions, care emerges not as a limit on innovation but as its ethical and political reorientation.

8.1. Contributions and broader implications

Thus, this article makes three broader contributions to research on ethics, technology, and gender in STEM. First, it shows that ethical technology design must be understood as an institutional as well as a design problem, bringing care ethics into direct dialogue with institutional gender theory and demonstrating why analyses confined to design principles alone remain incomplete. Second, by combining a narrative review of 308 papers with a focused synthesis of 40 case studies, it offers a clearer account of how dominant ethical paradigms continue to organize the field and where care ethics appears, with what possibilities and constraints, in practice. Third, it reframes care ethics not as a supplementary moral vocabulary, but as an analytical lens for examining how exclusion, legitimacy, and accountability are produced across technological and organizational settings. More broadly, the article suggests that inclusion cannot be reduced to representation or participation alone. It must also be understood in relation to the institutional conditions through which knowledge, labor, and evaluative worth are recognized or ignored.

8.2. Future research

The findings and limitations identified in this article point to several next steps for research. Future work should examine more directly how care-centered design practices are sustained, diluted, or reinterpreted under organizational and policy pressures, especially in STEM environments where output, neutrality, and technocratic efficiency remain dominant evaluative norms. Given care ethics' iterative, context-dependent, and power-sensitive orientation, longitudinal studies would be especially valuable for tracing how practical limitations

identified here, including lead-user bias, implementation frictions, uneven participation, cultural translation challenges, and the invisibility of relational and emotional labor, evolve over time and across institutional settings.

Comparative research across STEM organizations would also help clarify how different evaluative cultures, funding structures, and governance arrangements shape the uptake of care-informed design. Further research is needed to identify the institutional practices through which relational and affective labor can be recognized rather than absorbed into existing expectations, and to assess how care-based approaches can move beyond procedural adoption toward more substantive changes in design routines, workplace cultures, and accountability criteria.

Finally, future research could also examine how care ethics interacts with other justice-oriented ethical frameworks, such as Equity Ethics, particularly in relation to structural inequality, institutional accountability, and the distribution of risks and opportunities in technological systems. Such work could clarify how relational, care-oriented practices may complement more explicitly distributive and structurally focused approaches to justice.

9. References

Abu-Shanab, E., & Al-Jamal, N. (2015). Exploring the gender digital divide in Jordan. *Gender, Technology and Development, 19*(1), 91–113.

Academy of Finland. (2020). *Equality and nondiscrimination*. https://www.aka.fi/globalassets/1-tutkimusrahoitus/5-vastuullinen-tiede/academy-of-finland-equality-and-non-discrimination-plan.pdf

Acker, J. (1990). Hierarchies, jobs, bodies: A theory of gendered organizations. *Gender & Society, 4*(2), 139–158.

Alexander, L., & Moore, M. (2016). Deontological ethics. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Winter 2016 ed.). https://plato.stanford.edu/entries/ethics-deontological/

Allen, M., & Fischer, S. (2025, January 10). Meta kills DEI programs. *Axios*. https://www.axios.com/2025/01/10/meta-dei-programs-employees-trump

Allmark, P. (1995). Can there be an ethics of care? *Journal of Medical Ethics, 21*(1), 19–24.

Anderson, M., & Anderson, S. L. (2020). Machine ethics: Creating an ethical intelligent agent. In *Machine ethics and robot ethics* (pp. 237–248). Routledge.

Annas, J. (2003). *Virtue ethics and social psychology*. https://kb.osu.edu/handle/1811/32034

AP News. (2025, February 5). Google scraps its diversity hiring goals as it complies with Trump's new government contractor rules. https://apnews.com/article/16a937d5d9b6447251c4c40c2ad1c915

Bacchi, C., & Eveline, J. (2010). *Mainstreaming politics: Gendering practices and feminist theory*. University of Adelaide Press.

Bartky, S. L. (2015). *Femininity and domination: Studies in the phenomenology of oppression*. Routledge.

Bergeron, S. (2016). Formal, informal, and care economies. In L. Disch & M. Hawkesworth (Eds.), *The Oxford handbook of feminist theory* (pp. 385–406). Oxford University Press.

Binns, R. (2018). Fairness in machine learning: Lessons from political philosophy. In *Proceedings of the 2018 Conference on Fairness, Accountability, and Transparency* (pp. 149–159).

Biroli, F., & Caminotti, M. (2020). The conservative backlash against gender in Latin America. *Politics & Gender, 16*(1), Article E1.

Braybrooke, K., Janes, S., & Sato, C. (2021). Care-full design sprints: Addressing gaps in cultural access and inclusion during COVID-19 with vulnerable communities in London and Tokyo. In *Proceedings of the 10th International Conference on Communities & Technologies*.

Brey, P. (2012). Anticipatory ethics for emerging technologies. *NanoEthics, 6*(1), 1–13.

Bryson, M., & De Castell, S. (1996). Learning to make a difference: Gender, new technologies, and in/equity. *Mind, Culture, and Activity, 3*(2), 119–135.

Bürger, T., Jansen, M., & Ross, K. (2020). Not all tweets are created equal: Gender and politics in the platform age. *Feminist Media Studies, 20*(4), 586–589.

Caffrey, L., Wyatt, D., Fudge, N., Mattingley, H., Williamson, C., & McKevitt, C. (2016). Gender equity programmes in academic medicine: A realist evaluation approach to Athena SWAN processes. *BMJ Open, 6*(9), Article e012090.

Campbell, R., May, G., Duffy, B., Skinner, G., Gottfried, G., & Hewlett, K. (2024). *Emerging tensions? How younger generations are dividing on masculinity and gender equality*. The Policy Institute at King's. https://www.kcl.ac.uk/policy-institute/assets/emerging-tensions.pdf

CNN. (2025, May 29). MIT is shuttering DEI office amid Trump administration's push to end diversity programs. https://edition.cnn.com/2025/05/29/us/mit-shuttering-dei-office-hnk

Cochrane, K., Cao, Y., Girouard, A., & Loke, L. (2022, February). Breathing scarf: Using a first-person research method to design a wearable for emotional regulation. In *Proceedings of the Sixteenth International Conference on Tangible, Embedded, and Embodied Interaction* (pp. 1–19).

Connell, R. W. (2019). *Gender: In world perspective* (4th ed.). Polity Press.

Connolly, R., & Richardson, I. (2023). National culture and policy institutionalizing workplace change: Supporting women's career progression in STEM through Athena SWAN. In E. M. Trauth & J. L. Quesenberry (Eds.), *Handbook of gender and technology* (pp. 106–125). Edward Elgar Publishing.

Corredor, E. S. (2019). Unpacking "gender ideology" and the global right's antigender countermovement. *Signs: Journal of Women in Culture and Society, 44*(3), 613–638.

Crosby, F. J., & VanDeVeer, C. (2000). *Sex, race, and merit: Debating affirmative action in education and employment*. University of Michigan Press.

Cupać, J., & Ebetürk, I. (2020). The personal is global political: The antifeminist backlash in the United Nations. *The British Journal of Politics and International Relations, 22*(4), 702–714.

Dojčinović, N., & Ljajić, S. (2022). Trump's rhetoric on social networks and the dominance of computerized propaganda. *Društvene i Humanističke Studije, 7*(18), 131–148.

Eagly, A. H., & Karau, S. J. (2002). Role congruity theory of prejudice toward female leaders. *Psychological Review, 109*(3), 573–598.

Engster, D. (2006). Care ethics and animal welfare. *Journal of Social Philosophy, 37*(4), 521–536.

Engster, D. (2019). Care ethics, dependency, and vulnerability. *Ethics and Social Welfare, 13*(2), 100–114.

Faulkner, W. (2007). "Nuts and bolts and people": Gender-troubled engineering identities. *Social Studies of Science, 37*(3), 331–356.

Feeney, M. K., & Fusi, F. (2021). A critical analysis of the study of gender and technology in government. *Information Polity, 26*(2), 115–129.

Floridi, L. (2014). *The fourth revolution: How the infosphere is reshaping human reality*. Oxford University Press.

Floridi, L., & Taddeo, M. (2016). What is data ethics? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374*(2083), Article 20160360.

Forattini, F. (2025). Gender-focused technology design and care ethics integration: Addressing social and practical challenges. In *Proceedings of the 58th Hawaii International Conference on System Sciences* (pp. 6794–6803).

Forattini, F. M., Connolly, R., & Joshi, K. D. (2025). Breaking boundaries: Advancing gender and technology research to combat sextortion. *The DATA BASE for Advances in Information Systems, 56*(1), 6–10.

Franzke, A. (2022). An exploratory qualitative analysis of AI ethics guidelines. *Journal of Information, Communication and Ethics in Society, 20*(4), 401–423.

Gailán, C., Rubio, M., Escaroz, G., & Alejandre, F. (2023). *Care and support systems in Latin America and the Caribbean: A framework for UNICEF action*. UNICEF Latin America & Caribbean.

Gilligan, C. (1993). *In a different voice: Psychological theory and women's development*. Harvard University Press.

Goodin, R. E. (1995). *Utilitarianism as a public philosophy*. Cambridge University Press.

Grates, M. G., Heming, A. C., Vukoman, M., Schabsky, P., & Sorgalla, J. (2019). New perspectives on user participation in technology design processes: An interdisciplinary approach. *The Gerontologist, 59*(1), 45–57.

Haglund, L. (2020). The need for care: A study of teachers' conceptions of care and pupils' needs in a Swedish school-age educare setting. *International Journal for Research on Extended Education, 7*(2), 15–16.

Harsanyi, J. C. (1977). Morality and the theory of rational behavior. *Social Research, 44*(4), 623–656.

Health Research Council of New Zealand. (2019). *Te Ara Tika: Guidelines for Māori research ethics*. https://www.hrc.govt.nz/resources/te-ara-tika-guidelines-maori-research-ethics-0

Held, V. (2006). *The ethics of care: Personal, political, and global*. Oxford University Press.

Hilbert, M. (2014). Technological information inequality as an incessantly moving target: The redistribution of information and communication capacities between 1986 and 2010. *Journal of the Association for Information Science and Technology, 65*(4), 821–835.

Holtzblatt, K., & Marsden, N. (2018, June). Retaining women in technology. In *2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)* (pp. 1–8).

Hui, Y. (2019). *The question concerning technology in China: An essay in cosmotechnics* (Vol. 3). MIT Press.

Hursthouse, R. (1999). *On virtue ethics*. Oxford University Press.

Kalm, S., & Meeuwisse, A. (2023). The moral dimension of countermovements: The case of antifeminism. In A. Sevelsted & J. Toubøl (Eds.), *The power of morality in movements: Civic*

engagement in climate justice, human rights, and democracy (pp. 291–314). Springer Nature.

Kittay, E. F. (2011). The ethics of care, dependence, and disability. *Ratio Juris, 24*(1), 49–58.

Kuhar, R., & Paternotte, D. (Eds.). (2017). *Anti-gender campaigns in Europe: Mobilizing against equality*. Rowman & Littlefield.

Kuhse, H. (1997). *Caring: Nurses, women, and ethics*. Blackwell.

Leget, C., van Nistelrooij, I., & Visse, M. (2019). Beyond demarcation: Care ethics as an interdisciplinary field of inquiry. *Nursing Ethics, 26*(1), 17–25.

Light, A., & Akama, Y. (2014, October). Structuring future social relations: The politics of care in participatory practice. In *Proceedings of the 13th Participatory Design Conference: Research Papers* (Vol. 1, pp. 151–160).

MacIntyre, A. (2007). *After virtue: A study in moral theory*. University of Notre Dame Press.

Mendez, G. G., Hinrichs, U., & Nacenta, M. A. (2017, May). Bottom-up vs. top-down: Trade-offs in efficiency, understanding, freedom and creativity with infovis tools. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 841–852).

Montoya, C. (2016). Institutions. In L. Disch & M. Hawkesworth (Eds.), *The Oxford handbook of feminist theory* (pp. 628–645). Oxford University Press.

New York Post. (2025, May 28). MIT scraps DEI office, ends programs amid Trump's fight with Harvard. https://nypost.com/2025/05/28/us-news/mit-scraps-dei-office-ends-programs-amid-trumps-fight-with-harvard/

Noddings, N. (1984). *Caring: A feminine approach to ethics and moral education*. University of California Press.

Nurock, V., Chatila, R., & Parizeau, M. H. (2021). What does "ethical by design" mean? In J.-G. Ganascia & M. Taddeo (Eds.), *Reflections on artificial intelligence for humanity* (pp. 171–190). Springer.

Ovseiko, P. V., Chapple, A., Edmunds, L. D., & Ziebland, S. (2017). Advancing gender equality through the Athena SWAN Charter for women in science: An exploratory study of women's and men's perceptions. *Health Research Policy and Systems, 15*(1), 12.

Popper, K. R. (1945). *The open society and its enemies*. Routledge & Kegan Paul.

Rawls, J. (1971). *A theory of justice*. Harvard University Press.

Ross, W. D. (2002). *The right and the good*. Oxford University Press.

Sambasivan, N., Checkley, G., Ahmed, N., & Batool, A. (2017). Gender equity in technologies: Considerations for design in the global south. *Interactions, 25*, 58–61.

Scanlon, T. M. (2000). *What we owe to each other*. Harvard University Press.

Scheffler, S. (Ed.). (1988). *Consequentialism and its critics*. Oxford University Press.

Schradie, J. (2019). *The revolution that wasn't: How digital activism favors conservatives*. Harvard University Press.

Sharma, A., Punhani, G., & Aggarwal, S. (2021). A global perspective of ICT development indices: Gender the missing link. *International Journal of Information Communication Technologies and Human Development, 13*(4), 83–91.

Slote, M. A. (1993). *From morality to virtue*. Oxford University Press.

Spiel, K., Brulé, E., Frauenberger, C., Bailly, G., & Fitzpatrick, G. (2018, August). Micro-ethics for participatory design with marginalized children. In *Proceedings of the 15th Participatory Design Conference: Full Papers* (Vol. 1, pp. 1–12).

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy, 42*(9), 1568–1580.

Swanton, C. (2003). *Virtue ethics: A pluralistic view*. Clarendon Press.

Terrile, R., Jackson, B., & Belz, A. (2014). Consideration of risk and reward in balancing technology portfolios. In *2014 IEEE Aerospace Conference* (pp. 1–8).

Tronto, J. C. (1993). *Moral boundaries: A political argument for an ethic of care*. Routledge.

Vallor, S. (2016). *Technology and the virtues: A philosophical guide to a future worth wanting*. Oxford University Press.

Wajcman, J. (2011). Gender and work: A technofeminist analysis. In E. Jeanes, D. Knights, & P. Y. Martin (Eds.), *Handbook of gender, work, and organization* (pp. 263–275). Wiley.

Walker, M. U. (2007). *Moral understandings: A feminist study in ethics*. Oxford University Press.

Wilkinson, C. R., & De Angeli, A. (2014). Applying user-centered and participatory design approaches to commercial product development. *Design Studies, 35*(6), 614–631.

Winner, L. (2010). *The whale and the reactor: A search for limits in an age of high technology*. University of Chicago Press.

Wired. (2025, May 29). Grand Theft Auto publisher swaps DEI for "diversity of thought" in annual report. https://www.wired.com/story/grand-theft-autos-publisher-abandons-dei-for-diversity-of-thought-in-annual-report

Zeff, M. (2024, January). Silicon Valley has the woke mind virus on the brain. *MSN*. https://www.msn.com/en-us/money/other/trend-of-the-week-silicon-valley-has-the-woke-mind-virus-on-the-brain/ar-AA1mDgpY