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NOVATION

Critical Studies of Innovation

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Critical approaches to innovation and alternative policy models for innovation

Guest Editors

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About Us

The international journal *NOvation: Critical Studies of Innovation* was launched to contribute to the rethinking and debunking of innovation narratives in STS (Science, Technology and Society) and STI (Science, Technology, and Innovation). There is a need to critically examine studies of innovation and obtain a clearer portrait of innovation than the depiction this field has been accustomed to. The journal questions the current narratives of innovation and offers a forum for discussion of some different interpretations of innovation, not only its virtues, but also its implications. In this sense, NO refers to non-innovative behaviors, which are as important to our societies as innovation is. Failures, imitation and negative effects of innovation, to take just some examples of non-innovation or *NOvation*, are scarcely considered and rarely form part of theories of innovation.

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Table of Contents

Rethinking Innovation Beyond the Fable

Critical Pathways and Alternative Policy Models

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In recent decades, innovation has achieved an extraordinary position in political, economic, and cultural discourse. It has come to be seen as a universal remedy—a panacea capable of addressing social, environmental, economic, and political challenges while simultaneously driving growth and competitiveness. As highlighted in the call for this thematic issue and as critically framed by several authors already, this belief rests on a powerful modern narrative: a fable of progress driven by science and technology, a promise that the future will inevitably be better than the present because innovation will carry us there. Yet this fable has obscured the social, political, and environmental consequences of innovation systems designed around market logics, competition, and technological determinism. It has eclipsed alternative imaginaries of collective flourishing and dismissed deeper questions about who benefits from innovation, who bears its risks, and what other futures might become possible.

In response, the field of *Critical Studies of Innovation* has emerged to interrogate these assumptions. Building on the foundational work of Godin, Vinck, Pfotenhauer, and others, scholarship has exposed the ideological character of "innovationism" (Oliveira, 2011)—the belief that innovation is inherently good, that more is always better, and that societal problems are ultimately innovation deficits. The contributions gathered in this issue extend this critique, while also advancing conceptual and empirical foundations for alternative pathways. They address the contradictions of innovation regimes, expose the limits of 'x-innovation' (Gaglio *et al.*, 2019) rebrandings, analyse the politics of governance and directionality, and foreground community-based, solidaristic, and human-centered approaches that disrupt dominant models.

This issue has been deliberately structured to move from *historical-epistemic critique*, to *sectoral and institutional analysis*, to *territorial experimentation*, and finally to *conceptual and methodological tools* for rethinking innovation. Each article contributes a distinct lens, yet together they build a coherent argument: that the current innovation paradigm, rooted in neoliberalism, technological determinism, and a narrow economic rationality, is neither inevitable nor desirable, and that viable, situated alternatives already exist, albeit often marginalised or invisible.

1. DECONSTRUCTING THE ORIGINS OF PRO-INNOVATION EPISTEMOLOGY

The opening article by **Ryan T. MacNeil**, *Modelling innovation as toxic (techno-economic) positivity*. Some consequences of SPRU's attack on "The Limits to Growth", establishes the historical and epistemological foundation for the entire issue. In a meticulous reconstruction of the 1972–73 debate between the Club of Rome's *Limits to Growth* team and the newly formed Science Policy Research Unit (SPRU), MacNeil shows how SPRU's critique —ostensibly methodological—had long-lasting consequences for how innovation would be conceptualised, modelled, and governed. What SPRU defended was not merely better data, but a worldview anchored in *precision fetishism* and *techno-economic optimism*. Their response helped consolidate a belief in continuous technological progress capable of postponing or overcoming planetary limits. This stance, what MacNeil terms "toxic positivity", has since permeated innovation studies, reinforcing an ideology of growth, masking uncertainties, and marginalising precautionary or degrowth-oriented perspectives.

MacNeil's article thus performs a dual function within the issue: it exposes the epistemic roots of the pro-innovation bias and invites readers to reconsider the foundations upon which contemporary STI policies have been established. It signals that innovation is not a neutral or purely technical category, but a historically situated discursive formation with political effects. This sets the stage for the remaining papers, all of which, in different ways, challenge the assumptions inherited from this epistemic legacy.

2. INNOVATIONISM IN CULTURE AND TECHNOLOGY: POWER, AESTHETICS AND CONTRADICTIONS

If MacNeil describes the ideological foundations of innovationism, the second article examines how this ideology materialises in cultural and technological practice. **Yuri Gabriel Campagnaro**, in *Innovationism between Art and Technology: Technological determinism in the controversy around Vantablack*, turns to the widely publicised dispute involving Surrey NanoSystems, the artist Anish Kapoor, and his opponent Stuart Semple. Here, innovation appears not as a broad policy narrative but as a lived and contested cultural logic shaping material practices and symbolic meanings.

Campagnaro demonstrates that all actors involved—corporate, artistic, countercultural—remain entangled in the same innovationist regime. Surrey NanoSystems frames Vantablack as a breakthrough rooted in technological inevitability; Kapoor reinforces the association between novelty, exclusivity and artistic authority; Semple, despite his democratic rhetoric, relies on similar branding, spectacle and market strategies. The controversy thus reveals how deeply innovationism operates beneath divergent political and aesthetic claims. Importantly, Campagnaro shows that even attempts to resist innovationist logics may inadvertently reproduce them, highlighting the resilience of the dominant paradigm and the difficulty of constructing alternatives within the very cultural economy it shapes.

This article provides a bridge between abstract epistemic critique and concrete sociotechnical controversy. It demonstrates how technological determinism is enacted and reproduced in everyday practices, how exclusivity and marketization shape the cultural meaning of innovation, and how contradictions emerge within attempts to democratize access to technological materials.

3. CREATIVITY AS POLICY, AND THE INSTITUTIONAL CAPTURE OF ALTERNATIVES

The third contribution turns towards urban innovation policy. In *Curation, Compliance, Consolidation. Understanding the Limits of Innovation Policy's Turn to Creativity*, **Nadine O. Osbild** and **Sebastian Pfotenhauer** investigate Munich's creative districts—spaces ostensibly designed to foster alternative, experimental forms of innovation. Drawing on an STS-informed ethnographic approach, they identify three mechanisms—*curation*, *compliance*, and *consolidation*—through which creativity is domesticated and instrumentalised.

Rather than enabling radical experimentation, Munich's creative districts reinforce a conservative regional innovation culture, privileging high-tech, economically legitimised activities while marginalising subcultural, social, or politically contestatory forms of creativity. Creativity becomes a branding tool, a form of soft power deployed to increase attractiveness and competitiveness, rather than a space for democratic or convivial alternatives. Osbild and Pfotenhauer thus expose a pattern familiar across many global cities: the rhetoric of creativity conceals the reproduction of exclusionary structures and elite-driven innovation agendas.

Their article marks the transition, in this thematic issue, from epistemic critique to institutional analysis. It demonstrates how the innovation paradigm not only shapes discourse but also reconfigures urban spaces, governance mechanisms, and the distribution of opportunities.

4. ALTERNATIVE INNOVATION PATHWAYS: DIRECTIONALITY, KNOWLEDGE SYSTEMS AND TERRITORIALITY

The next two articles shift focus to national and territorial contexts, examining how alternative innovation policies emerge, circulate, and are appropriated by diverse actors.

In *Steering the Course. Negotiating Directions in Alternative Research and Innovation Policies for Transformative Change*, **Gabriela Bortz** and **Ayelén Gázquez** offer an empirically rich and conceptually sophisticated analysis of two long-term Argentine initiatives—*Yogurito* and the *Paraná River Aquarium*. Drawing on an expanded *Knowledge Systems* (KS) approach, they show how innovation trajectories are not linear or predetermined, but *negotiated across actors, knowledge bases, institutional arrangements, and shifting political priorities*. The authors identify competing directionalities—competitiveness, poverty reduction, sustainable development, and transformative change—each shaping how innovation is enacted. Their work demonstrates that alternative innovation policy frameworks require flexible, contextually grounded governance arrangements capable of accommodating ambiguity, contestation and learning.

In the subsequent article, *Translating Transformative Innovation Framework in Colombia*, **Nicolás Garzón Rodríguez** and **Janaina Pamplona da Costa** analyse the transfer and translation of the Transformative Innovation Policy (TIP) framework into Colombia's STI governance system. They show that TIP did not arrive as a ready-made model but was reinterpreted through the country's long-standing traditions of social

innovation and Science and Technology Appropriation (SASTI). The result was a territorialised, bottom-up version of TIP focused on niche-building and inclusive participation. While this translation empowered regional actors and marginalised groups, it also limited TIP's transformative potential by confining it to small-scale experiments disconnected from mainstream policy instruments. The authors reveal the politics of translating global frameworks into peripheral contexts, highlighting both the opportunities and the structural constraints that shape alternative innovation models.

Together, these two contributions foreground a crucial insight: *alternative innovation policies are not imported, but co-produced* (or at least should be) *through local histories, territorial dynamics and institutional arrangements*. They illuminate the complexity of designing and governing transformative STI systems, as well as the need to understand innovation directionality as a dynamic and contested process.

5. GRASSROOTS INNOVATION AND THE SOCIAL SOLIDARITY ECONOMY

While Bortz and Gázquez, and Rodríguez and Pamplona da Costa examine alternative innovation at the level of national systems and territorial governance, **Les Levidow**, **Theo Papaioannou**, **Zühre Aksoy** and **Özlem Öz** turn to grassroots practices. In *Grassroots Innovation Ecosystems. Alternative Agri-Food Networks (AAFNs) in Brazil and Turkey*, they develop a tripartite framework—*Inclusive grassroots innovation, agile solidarity, and transformative resilience*—to analyse Social Solidarity Economy (SSE) ecosystems in agri-food networks. Their comparative study shows that SSE-based AAFNs do not simply provide technical innovations, but co-create *sociotechnical alternative*s grounded in mutual aid, care, democratic governance and territorial embeddedness. During crises such as Covid-19, these networks exhibited rapid adaptation, sustaining livelihoods, expanding access to healthy food and mitigating inequalities. Women's networks, agroecological circuits and community-supported agriculture played vital roles in constructing inclusive innovation pathways. Yet these ecosystems remain vulnerable to structural constraints, from neoliberal food regimes to the erosion of supportive public policies.

Levidow and Papaioannou thus offer perhaps the most direct counterpoint to mainstream innovation models within the issue, as they demonstrate that *radically different innovation ecologies already exist*, often operating at the margins of visibility. Their article demonstrates that alternatives need not be hypothetical futures—they can be found in the solidaristic practices that sustain communities today.

6. HUMAN AND SOCIAL FACTORS IN INNOVATION: A MULTILEVEL ANALYTICAL TOOL

Closing the issue, **Eduard V. Patrakov**, **Rafael de Brito Dias**, **Rodrigo F. Frogeri** and **Lioudmila I. Baturina** provide an integrative and forward-looking contribution. *The Human and Social Factors of Technological Innovations: Risks and Resources Analysis Model* build a conceptual bridge between critical innovation studies, psychology, philosophy of technology and risk analysis. The authors argue that innovation systems have neglected the psychological, emotional, and cultural dimensions of innovation—dimensions that profoundly shape how innovations are created, adopted, and governed.

They propose a *three-level analytical model*—macro (society), meso (organizations), micro (individuals)—for identifying both *risks* and *resources* associated with innovation processes. This model serves as a practical tool for policymakers, organizations, and researchers seeking to design human-centered innovation policies that are attentive to trust, values, anxiety, identity, autonomy, and well-being. In doing so, the article synthesizes many themes raised by earlier contributions—directionality, governance, inequality, techno-determinism—while offering a concrete methodological framework for moving beyond critique.

7. CONVERGENCES AND OVERALL CONTRIBUTION OF THE THEMATIC ISSUE

Although diverse in methods, geographies, and theoretical frameworks, the seven articles converge on several key points that define the intellectual contribution of this thematic issue:

1. **Innovation is not neutral:** it is historically situated, politically charged, and deeply ideological. It distributes risks and benefits unevenly. It shapes, and is shaped by, power relations.

2. **The dominant model of innovation is failing.** Across culture, urban development, national governance, rural economies, and psychological experience, we observe that innovation regimes reproduce inequalities, marginalize alternative knowledge systems, and prioritize economic competitiveness over social and environmental well-being.

3. **Alternatives already exist.** Whether through SSE-based agri-food networks, territorially based TIP frameworks, creative subcultures, feminist networks, agroecology, or knowledge-system approaches, the issue demonstrates that plural innovation pathways are not only possible but are also underway.

4. **Alternative innovation requires rethinking directionality.** Innovation must be guided by explicit social aims—such as equity, sustainability, care, justice, and conviviality—rather than by the implicit imperatives of growth and competitiveness.

5. **Governance matters:** territorial structures, institutional arrangements, funding mechanisms, policy instruments, and cultural norms all shape innovation trajectories. Transformative models depend on inclusive, negotiated, and flexible governance architectures.

6. **Human experience is central.** Innovation cannot be understood or governed without considering the psychological, emotional, and cultural dimensions through which individuals and communities engage with technological change.

Collectively, the articles in this issue take critical innovation studies a step further: not only diagnosing the problems of *innovationism*, but also identifying and theorising the diverse ecosystems, practices, and policy approaches that can support more just, sustainable, and democratic forms of innovation. They invite scholars, practitioners, and policymakers to rethink innovation beyond the narrow confines of competitiveness and technological progress, and to engage seriously with the question of what kinds of futures innovation should serve.

8. A CLOSING REFLECTION

The narrative of innovation as a self-evident good—whether framed as progress, competitiveness, or modernity—has reached a point of exhaustion. As we did remind in the framing text for this issue, innovation has become "the jewel in the crown of neoliberalism," a myth that encourages movement without direction and faith without reflection. To move beyond this fable, we must cultivate epistemic humility, institutional imagination, and democratic governance. We must ask anew: innovation for whom, by whom, and toward what ends?

This thematic issue demonstrates that such questions are not merely theoretical. They are present in urban struggles over creative districts, in artistic controversies over material monopolies, in rural networks that feed cities, in national STI systems that shape territorial futures, and in the psychological landscapes through which individuals navigate technological transformation. By bringing these diverse perspectives together, the issue aspires to contribute not only to academic debate, but to the ongoing project of designing *alternative innovation regimes* grounded in justice, solidarity, sustainability, and care.

We hope this collection serves as both an invitation and a provocation: an invitation to explore the multiplicity of innovation pathways that exist beyond innovationism; and a provocation to reimagine the role of innovation in building the collective futures we desire.

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Modelling innovation as toxic (techno-economic) positivity

Some consequences of SPRU's attack on "The Limits to Growth"

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ABSTRACT

The Science Policy Research Unit (SPRU) at the University of Sussex played a significant role in establishing innovation studies as a field and in establishing innovation policy as a framework for governmental thinking. But the SPRU's first book was not directly about innovation; it was "Thinking about the future: a critique of the Limits to Growth" (1973). The "Limits to Growth" (1972) had been an attempt by researchers at MIT, funded by the Club of Rome and the Volkswagen Foundation, to quantitatively falsify the idea of endless growth on a finite planet. The SPRU's response—later reprinted with the title "Models of Doom" outside the UK—was one of many that framed "Limits" as overly pessimistic. This paper considers the impact of this work on the developing fields of innovation research and policy. It takes a critical ethnostatistics approach to the modelling practices deployed by these two very different groups of professional social scientists. It focuses on two methodological moves made by the SPRU researchers. First, this paper shows how the SPRU arguments established a fetish for data precision—a standard that the MIT team rejected, but one that carried on through the SPRU's further work into innovation research and policy. Next, it discusses how the SPRU researchers (role)modelled mathematical faith in socio-technical change. This was more than a techno-optimist (or Promethean) stance. It established a norm of toxic positivity around questions of technology, innovation, and the environment. These two methodological moves—fetishizing data precision while asserting toxically positive Prometheanism—became cultural memes that carried forward from this debate into innovation policy, modelling, and statistical practices. In short, the pro-innovation econometrics developed for this debate by the SPRU researchers had a lasting impact on the epistemic culture of innovation studies.

Keywords: Degrowth; Ethnostatistics; Methods; Sustainability; System Dynamics; Techno-optimism.

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INTRODUCTION

Histories of innovation highlight the centrality of the *Science Policy Research Unit* (SPRU) at the *University of Sussex*. The writings of Christopher Freeman especially, but also many other SPRU researchers, played a significant role in establishing innovation studies as a field of research and in establishing innovation policy as a distinct framework for governmental thinking about economy and society (Fagerberg *et al.*, 2011; Fagerberg *et al.*, 2012; Fagerberg *et al.*, 2013; Soete, 2019, p. 89). Research at the SPRU shaped innovation models toward a systems approach and normalized statistical measurements of innovation. But before all this, the SPRU began building its reputation—and establishing some field-defining norms—with its first book: *Thinking about the future: a critique of the Limits to Growth* (Cole *et al.*, 1973b).

The *Limits to Growth* (Meadows *et al.*, 1972) was an attempt to quantitatively falsify the assumption that endless growth is possible on a finite planet. It was prepared by a team of researchers at the MIT's management school: Donella Meadows, Dennis Meadows, Jørgen Randers, and William Behrens III. They used a new computer-driven "system dynamics" approach to quantitative modelling developed by Jay Wright Forrester (1973). This work was sponsored by the *Club of Rome*—"an informal organization" of "scientists, educators, economists, humanists, industrialists, and national and international civil servants" who shared a "conviction that the major problems facing mankind are of such complexity and are so interrelated that traditional institutions and policies are no longer able to cope with them" (Meadows *et al.*, 1972, p. 9-10). The group felt a great sense of urgency over these challenges and chose to proceed with limited data and an imperfect model. As the authors of *Limits* explained, "We hope that it will lead thoughtful men and women in all fields of endeavor to consider the need for concerted action now if we are to preserve the habitability of this planet for ourselves and our children" (Meadows *et al.*, 1972, p. 12). And, despite its methodological density, the work did find a very wide readership that extended well beyond research and policy circles[1] (see Forrester, 1989). It sold over 10 million copies in 30 languages (Ramage and Shipp, 2009, p. 109). It also garnered tremendous criticism—especially from economists.

The SPRU response was one of many that presented alternative (political) assumptions and modelling (see also Herrera, 1977; Kahn *et al.*, 1976; Maddox, 1972; Nordhaus, 1973; Vermeulen and de Jongh, 1976). Like others, the SPRU team criticized the assump-

[1] Propelled by coverage in news and popular media—apparently including an article in eight million copies of *Playboy* magazine (Forrester, 1989).

tions of the MIT model and its statistical imprecision. More importantly, the SPRU critique also advanced the view that sufficient socio-technical progress can overcome—or at least significantly and continuously delay—any natural limits. For this reason, they characterized *Limits* as overly pessimistic about the future. The SPRU book was then quickly reprinted for an international audience as *Models of Doom…* (Cole *et al.*, 1973a). This helped characterize the MIT/Club of Rome as doomsayers. Others joined that chorus (see discussion in Higgs, 2014). And the doomsday rhetoric was "effective in blunting the impact of the critique of growth and remains popular with think tanks and economists today" (Higgs, 2014, p. 54). The SPRU was one of several groups that advanced the "optimistic" view that human ingenuity will conquer any limits to growth.

Kerryn Higgs (2014) and Elodie Vieille Blanchard (2010; 2015) have both examined the impact of this early SPRU research within the broader *Limits to Growth* debate. In this paper, I reverse that line of inquiry. I am interested in the impact the *Limits* debate had on the SPRU and on the developing fields of innovation research and policy. Taking a critical ethnostatistics approach (Gephart, 1988, 2006), I examine the methodological norms that were advanced by SPRU researchers in this debate. I argue that the pro-innovation position SPRU researchers developed for *Models of Doom*—and several related follow-up books (i.e., Encel *et al.*, 1975; Freeman, 1992; Freeman and Jahoda, 1978; Miles, 1975)—had a lasting impact on the epistemic culture (Knorr-Cetina, 1999) of innovation studies.

Present-day SPRU researchers, Adrian Smith and Adrian Ely (2025), have recently written about the lasting impact of the *Models of Doom*. Their paper (Smith and Ely, 2025) focuses on questions of post-growth and post-colonial justice for the "Third World" or Global South. The SPRU and the Bariloche Foundations (Herrera, 1977) both criticized *Limits* for failing to acknowledge global inequities. Smith and Ely (2025) argue that the SPRU's hopes for global justice were later dashed by the rise of neoliberalism. What remained was the SPRU team's "shared hope in the ability of technology to decouple economic growth from environmental collapse" (Smith and Ely, 2025, p. 2). They say: "this hope has been prominent in policy ever since" (Smith and Ely, 2025, p. 2). And that is where this paper comes in. I am interested in the consequences of the SPRU's excessive techno-optimism on innovation research and policy. As Hickel and Kallis (2020) point out, "there is no empirical evidence that absolute decoupling from resource use can be achieved on a global scale against a background of continued economic growth" (p. 469). Nonetheless, present-day innovation studies continue aspiring toward techno-fixes (Pansera and Fressoli, 2021; Sharma *et al.*, 2025).

Unfortunately, it is now taken-for-granted that "innovation stretches the limits to growth" (Pansera and Fressoli, 2021, p. 381). Mario Pansera and Mariano Fressoli (2021) have said that "this view has become normalized and it is today a matter of fact for most governments and international institutions" (p. 381). Like Pansera and Fressoli (2021), I believe that "untangling innovation from growth is key to imagine a post-growth era" (p, 380). But while they credit this entanglement to "the revival of Schumpter's ideas in the 1980s" (Pansera and Fressoli, 2021, p. 381), my work here traces it back a decade earlier. In the *Limits* debate, "innovation-as-endless-growth" became embedded in methodological practices and disciplinary norms.

These methodological norms have had far reaching effects. Christophe Cassen and Béatrice Cointe (2022) examined changes in global computer models and found that, beginning in the *Limits* debate, "technological change progressively became a parameter in models as more elaborate methodologies were developed to simulate it" (p. 610). Similarly, Michael Keary (2016) said that "environmental modelling, powered by models of technological change, is now the most significant locus of technological optimism," and "…worryingly, green thought has not caught up" (p. 8). It is therefore surprising that "the STS literature engages with the politics of technology but does not adequately engage with the *Limits* to Growth debate" (Sharma *et al.*, 2025, p. 218). This debate was where "innovation-as-endless-growth" became an epistemic point-of-departure for future socio-economic research and policy.

My own epistemic point-of-departure for this paper is a place where the intellectual histories of innovation (Godin, 2011, 2012, 2017, 2019, 2020) meet the methods of critical organizational history (Durepos *et al.*, 2021; MacNeil, 2024). I begin with some discussion of what is meant by "epistemic culture" (Knorr-Cetina, 1999) and explain how a critically- and historically-conscious approach to "ethnostatistics" (Boje *et al.*, 2006; Gephart, 1988, 2006; Helms Mills *et al.*, 2006) can help to surface scholarly norms from statistically dense texts. After describing my approach, I provide an overview of the debate between the MIT and SPRU research teams. I briefly describe the modelling methods that were used for *Limits* (Meadows *et al.*, 1972) and then the alternative methodological assumptions contained in the SPRU response (i.e., Cole *et al.*, 1973a; Cole *et al.*, 1973b). This is followed by specific discussion of the two key methodological memes (i.e., on-going disciplinary practices) that I identified within the SPRU critique of *Limits*. First, the SPRU researchers established a fetish for data precision. Next, they ignored that norm and (role)modelled mathematical faith in socio-technical change. I present each of these methodological moves in turn.

I conclude with the broader point that *Models of Doom* was an important early boundary-setting contribution to innovation research and policy. Although the resulting books are not known as contributions to innovation studies, they are traces of the earliest work at the SPRU. The SPRU researchers were sharpening their analytical tools, building their research group's reputation, and establishing new disciplinary norms. This is more than an instance of techno-optimism. The legacy of this debate is a research/policy field concerned with social and environmental justice but burdened by toxically positive assumptions about innovation, economic growth, and planetary limits.

MY APPROACH

INTELLECTUAL HISTORIOGRAPHY

Benoît Godin (2020) longed for innovation to have many more historians and noted the limitations of a field dominated by econometrics (Godin, 2017). His work examined the historical development of ideas about technological innovation (Godin, 2019, 2020; Godin and Vinck, 2017b), the establishment of innovation studies as a discipline (Godin, 2012, 2014), the development of theoretical models to explain innovation (Godin, 2006, 2017; Godin and Lane, 2013), and the standardization of innovation surveys and measurements (Godin, 2002, 2005). While Godin's approach arose from the history of science and technology, mine comes from training in critical organizational history (Durepos *et al.*, 2021). Critical organizational history (COH) drew on the postmodern turn in history and then followed the amodern (or "new materialist") turn in STS (see Durepos and Mills, 2012). It is heavily influenced by authors such as Derrida (1996), Deleuze and Guattari (1987), Haraway (1988), Latour (1987), Law (1994), and Mol (2002). Durepos, Shaffner, and Taylor (2021) describe COH as "a theoretically informed historicized approach to understanding how and why we come to be where we are in contemporary organized societies" (p. 449). Many contributions to COH are acutely and reflexively concerned with method (e.g., Durepos and Mills, 2012; Hartt *et al.*, 2020; Williams, 2021). In prior work, I have demonstrated how a COH approach can disrupt the taken-for-granted methodological assumptions of innovation research (MacNeil, 2024). There, I re-examined the history of theoretical models—i.e., the linear (push/pull), chain-linked, and systems models of innovation. Here, my focus is on specific mathematical modelling practices.

ETHNOSTATISTICS

Karin Knorr-Cetina (1999) wrote about the cultures of different scientific disciplines. She examined the scientific practices in high-energy physics and in microbiology. This provided a lesson on how two very different disciplinary traditions (i.e., epistemic cultures) make knowledge in two very different ways. Laboratory ethnographies like this have been fundamental to understanding contemporary scientific practices as socio-material enactments. This new materialist perspective has since been adapted to the study of past management and organizational theories and practices (Durepos, 2015; Durepos and Mills, 2012). In this paper, I push it further by focusing on past practices of statistical modelling. Following Knorr-Cetina (1999), I am not interested in identifying the best or most highly developed scholarly practices. I am interested in understanding how different knowledges arise from different norms.

My work was informed by ethnostatistics: a methodological approach from organizational studies focused on the cultural practices around numbers (Gephart, 1988, 2006). Robert Gephart (2006) defined it as "the empirical study of how professional scholars construct and use statistics and numerals in scholarly research" (p. 417). It is a sparsely used method, with very limited use in innovation statistics (e.g., Kilduff and Oh, 2006). Elsewhere, I have argued that ethnostatistics might provide new ways to (re)consider the problems of standardized quantitative methods and measurements in innovation research (see MacNeil, 2024, Chapter 7). It provides a different way to build on the existing critique of innovation numbers (e.g., Gault, 2018, 2020; Godin, 2002, 2005). For this paper, it also provides a new way to disentangle notions of "growth" and "innovation" (cf. Pansera and Fressoli, 2021). It allows me to focus on the ways that "growth" and "innovation" became entangled in past practices of quantitative econometric modelling.

My primary focus is on the debate that occurred across three books: *Limits*... (Meadows *et al.*, 1972), *Thinking*... (Cole *et al.*, 1973b), and *Models*... (Cole *et al.*, 1973a). Interestingly, these books describe the in-person meeting that was held between the MIT and SPRU research teams prior to their publication (see Cole *et al.*, 1973a, pp. 216-240; Meadows *et al.*, 1973). The reprint of the SPRU text (Cole *et al.*, 1973a) was also published as a special issue of the journal *Futures* (see Streatfeild, 1973). Both the reprinted book and the special issue contain a sharp response to the SPRU from the MIT team. Nonetheless, I approached all these texts as mere traces of past statistical practices. Not having access to a time machine means that I cannot access the real past. I can only access the ways these authors described their work. I can only produce a situated understanding of past practices through my reading of the traces that remain.

To supplement my understanding of the primary texts, I also examined several other directly related texts (i.e., Encel *et al.*, 1975; Freeman and Jahoda, 1978; Miles, 1975), other unrelated texts from and about the SPRU during this period (i.e., Fagerberg *et al.*, 2011; Freeman, 1974; Soete, 2019), the authors' later reflections on this debate (i.e., Freeman, 1992; Meadows and Robinson, 1985; Meadows *et al.*, 2018; Meadows *et al.*, 2004), a documentary film about *Limits* (i.e., Enrico, 2013), and other sociological and historical investigations of the debate (i.e., Bloomfield, 1984; Higgs, 2014; Smith and Ely, 2025; Vieille Blanchard, 2010; Vieille Blanchard, 2015). Across these sources, my focus was on understanding how the SPRU researchers were constructing their arguments and using mathematical ideas. I was looking for evidence of the epistemic culture(s) swirling around the SPRU-side of this scholarly debate.

OVERVIEW OF THE DEBATE

LIMITS TO GROWTH

Work on *The Limits to Growth* (Meadows *et al.*, 1972) began when Forrester attended a meeting of the Club of Rome in Switzerland on June 29-30, 1970 (Lane, 2007). Forrester was an accomplished engineer and engineering professor who had transferred into MIT's management school shortly after it was established in the 1950s (Ramage and Shipp, 2009). In addition to his technical inventions, Forrester is credited with the development of system dynamics (Lane, 2007)—an approach to "modelling" or simulating the interaction of elements in a complex system. At first, this method was applied to the simulation of industrial dynamics, such as supply chains and industrial production processes (Forrester, 1961). Forrester had also recently applied his method to questions of "urban dynamics" (Forrester, 1969). At the Club of Rome meeting, he promoted the use of his method for understanding the Club's many interrelated social and environmental concerns. Given the enthusiastic response, he sketched his mental model of "world dynamics" on the flight home. His original sketch is reproduced in Lane (2007). With some refinement, Forrester is said to have produced the first computer model in a few days. He called this model "World 1." Within a month, he presented a second version to Club of Rome members who came to visit him at MIT. With funding from the Volkswagen Foundation, a team was hired to advance the model further, led by Forrester's former PhD student, Dennis Meadows. However, it was Dennis' wife Donella Meadows—with her PhD in biophysics from Harvard—who would become the lead author of *Limits* (see Ramage and Shipp, 2009).

The book presented results from a model the authors called "World3." The model was illustrated, similarly to Forrester's original sketch, as a nodes-and-links diagram of many interrelated social, economic, and environmental forces (on fold-out pages 102 and 103, in Meadows *et al.*, 1972). Data was attached to each node (e.g., population, birth rate, etc.) and each link represented a mathematical relation between factors/forces in the model. This was not a linear diagram; the model included many complex interrelations. The authors explained that "our world model was built to investigate five major trends of global concern—accelerating industrialization, widespread malnutrition, depletion of non-renewable resources, and a deteriorating environment" (Meadows *et al.*, 1972, p. 21). And they described their work as:

> A preliminary attempt to improve our mental models of long-term, global problems by combining the large amount of information that is already in human minds and in written records with the new information-processing tools that mankind's increasing knowledge has produced—the scientific method, systems analysis, and the modern computer. (Meadows *et al.*, 1972, p. 21)

Meadows *et al.* (1972) argued that expressing their work as a formal mathematical model meant that their assumptions about the world became more precise and "open to inspection and criticism by all" (p. 22). They also argued that the use of a computer allowed the team to "extend our intuitive capabilities so that we can follow the complex, interrelated behaviour of many variables simultaneously" (Meadows *et al.*, 1972, p. 89). This was at a time when there was growing excitement over the use of computers across social science.

The numerical results of the model are presented in over 200 pages of detailed charts, tables, and text. In broad strokes, the MIT team's conclusion was that "if the present growth trends…continue unchanged, the limits to growth on this plant will be reached within the next one hundred years" (Meadows *et al.*, 1972, p. 23). They pointed to others who had already come to similar conclusions. And they asserted that "we do not expect our broad conclusions to be substantially altered by further revisions" (Meadows *et al.*, 1972, p. 22). Nonetheless, Meadows *et al.* knew these numbers and this model would be quickly subjected to intense scrutiny.

The MIT team had held pre-publication meetings with at least two other research groups—SPRU and Hudson—that did not completely agree with their methods or conclusions (see discussion in Cole *et al.*, 1973a; Kahn *et al.*, 1976). And so, *Limits* is full of warnings and caveats. The authors warned that "these graphs are *not* exact predictions of the values of the variables at any particular year in the future. They are indications of the system's behavioural tendencies only" (Meadows *et al.*, 1972, p. 93, emphasis in original). They also admitted that,

> The model we have constructed is, like every other model, imperfect, oversimplified, and unfinished. We are well aware of its shortcomings, but we believe it is the most useful model now available for dealing with problems far out on the space time graph. (Meadows *et al.*, 1972, p. 21)

Nicolas Georgescu-Roegen (1975) later suggested that this embrace of imperfection is what triggered the fiercest criticism of *Limits*. The analytical approach used by the MIT group resembled econometrics, but it did not meet those epistemic standards. "From all one can judge, it was this fact that irked economists to the point of resorting to direct or veiled insults in their attack" (Georgescu-Roegen, 1975, p. 364). Meadows *et al.* proceeded, nonetheless. They asserted that decisions were being made everyday that could have long-term repercussions for the "world system"—and they argued that those decisions "cannot wait for perfect models and total understanding" (Meadows *et al.*, 1972, p. 22).

MODELS OF DOOM

Researchers at the SPRU invited Dennis and Donella Meadows to visit the University of Sussex in July 1972—only months after the publication of *Limits*. There was "a valuable and constructive discussion" (Cole *et al.*, 1973b, p. vi). The Meadows provided the SPRU team with technical reports to accompany the analysis in *Limits*. Dennis Meadows left the meeting with the impression that the SPRU team generally agreed with *Limits* (see Enrico, 2013). But the SPRU team left these conversations "convinced that they [MIT] would prefer frank and professional criticism to flattery" (Cole *et al.*, 1973b, p. vi). Within less than a year, the SPRU published its edited volume of papers criticizing the MIT model. In less than a year again, this was reprinted as *Models of Doom* (Cole *et al.*, 1973a). Both editions of the SPRU response (Cole *et al.*, 1973a, 1973b) contain the same 14 chapters authored by a team of 13 researchers. The reprint (Cole *et al.*, 1973a)—which also appeared as a special issue of the journal *Futures* (see Streatfeild, 1973)—added a 24 page response from the authors of *Limits*. All this text contains evidence of the dramatically different approaches to "modelling" valued by the two project teams.

In his introductory chapter, Freeman sums up the SPRU response by saying "the criticism is extensive, and sometimes severe" (Cole *et al.*, 1973b, p. 5). Harvey Simmons, a Canadian political scientist who worked on the project as a Visiting Fellow at the SPRU, wrote more vividly that the MIT team's "apocalyptic visions of the immediate future are tempered by the glittering image of utopia barely discernible through the fire and brimstone that rages in the historical foreground"—he then quickly noted that "this is not to denigrate the beliefs of the Forrester/Meadows school in any sense" (Cole *et al.*, 1973b, p. 207). Indeed, the SPRU team seems to have generally agreed on the fact that some

real physical limits to growth do exist. However, they concluded that the real challenge facing the world was one of insufficient socio-technical development—especially in the Global South (see discussion in Smith and Ely, 2025).

The SPRU team expressed concern that global policy makers might not work toward the necessary socio-technical change after reading the "doomsday" predictions within *Limits*. In one of his chapters, Keith Pavitt noted that "people tend to believe predictions and their conclusions and policy recommendations tend to creep into the collective psyche" (Cole *et al.*, 1973b, p. 156). Elsewhere, Pauline Marstrand and Craig Sinclair worried that attention might be "drawn away from what are urgent, and still soluble problems, and diverted into speculation upon an imaginary race against time between 'life' and 'global asphyxiation'" (Cole *et al.*, 1973b, p. 88). And Marie Jahoda, who chaired the SPRU project team, worried that reading *Limits* might "restrict, not to say paralyze decision makers now in taking actions on current urgent problems, actions which in their total impact may well contribute the most powerful negative feedback loop to falsify the doomsday curves" (Cole *et al.*, 1973b, p. 215). At the same time, she worried that her own team's criticism might similarly disarm policy makers. She wrote that the SPRU's assertion "that Forrester and Meadows have gone wrong must not lead to the conclusion that we can sit back and relax in the best of all possible worlds" (Cole *et al.*, 1973b). She was disagreeing with the construction of the MIT model but agreeing with the need for action.

Yet somehow the SPRU researchers could not come to their own agreement on whether *Limits* was in favour of socio-technical change. In one section, Craig Sinclair wrote that the MIT approach "explicitly rejects the possibility that improved social control mechanisms may diminish the risk of disasters" (Cole *et al.*, 1973b, p. 181). Like others on the SPRU team, he seems to have felt that *Limits* ought to have assumed socio-technical change would occur impulsively in response to the system-level threats. Many passages of the SPRU text argue that socio-technical change was missing from *Limits* and ought to have been built into the math. But later, Harvey Simmons wrote that "Forrester and his men" were "stressing that political solutions will be needed to prevent world disaster" (Cole *et al.*, 1973b, p. 193). And William Page wrote that,

> …they are not attempting to predict the future, but to show the possible consequences of present trends and relationships continuing without drastic change. Indeed the message of most of the doomsday authors is not that forecasts are necessarily expected to materialize—but that they could do so if appropriate action is not taken now. (Cole *et al.*, 1973b, p. 172)

Here, Page appears to have been more sympathetic to the *Limits* approach and model than the others on the SPRU project team.

Most members of the team found that corrections to the MIT numbers and assumptions would dramatically change the results. Pavitt explained: "there will not be a crisis of the form described in the models, if historical trends [in social, political, and technical change] continue" (Cole *et al.*, 1973b, p. 153). And to summarize the SPRU conclusions, Freeman said, "…in general we do not believe that the physical constraints are quite so pressing as the MIT team suggests. We do not accept their enthusiastic endorsement of zero growth as the ideal for the world" (Cole *et al.*, 1973b, p. 10). The SPRU team saw too many problems with the modelling presented in *Limits*. While Freeman certainly expressed strong environmental values during his career (e.g., Freeman, 1992; Freeman, 1996), and concern for the environment was expressed in various parts of the SPRU text, other key values separated the MIT and SPRU project teams.

When the prominent Marxist David Harvey soon entered the *Limits* debate, he explained the conflict between MIT and SPRU in simple terms. He said, "the difference between the Meadows model and the Sussex team's refashioning of it is largely due to the pessimism of the former and the optimism of the latter" (Harvey, 1974, p. 271). These pessimism/optimism labels were later refined when Herman Kahn's Hudson Institute entered the fray with their own modelling (Kahn *et al.*, 1976). They constructed a table outlining different positions that had already been taken within the *Limits* debate. On the pessimistic extreme they positioned the MIT team and its supporters under the heading, "the convinced neo-Malthusians" (Kahn *et al.*, 1976, p. 10). It had become common shorthand to criticize *Limits* by invoking the old theories, classist politics, and modelling errors of Thomas Malthus (who wrote about population growth almost 200 years earlier). However, this was an oversimplification of the MIT perspective (Vieille Blanchard, 2015). Meanwhile, on the optimistic extreme, Kahn *et al.* (1976) positioned the SPRU in a group they called "the technology and growth enthusiasts" (p. 10). This highly optimistic perspective was focused on an "unlimited pie" where technology "solves almost all problems" (Kahn *et al.*, 1976, p. 10). By and large, the Hudson team ascribed to this position themselves. They said, "Man has always risen to the occasion and will do so in the future despite dire predictions from the perennial doomsayers who have always been scandalously wrong" (Kahn *et al.*, 1976, p. 10). For the critics at the SPRU and Hudson, this pattern of "rising to the occasion" was a fundamental oversight in the mathematical modelling of *Limits*.

ANALYSIS

My analysis further complicates the distinction between "optimistic" and "pessimistic" modelling assumptions. In the following short sections, I will describe two methodological differences between the modelling teams at the SPRU and MIT. My focus is on identifying the emergent scientific norms at the SPRU from their written arguments and differences in technical approach. First, I will describe how that the SPRU's work on *Limits* fetishized data precision. Then, I will show how the SPRU's work (role)modelled faith in socio-technical change. I will argue that this was more than simple techno-optimism; *Models of Doom* initiated a toxically positive disciplinary norm.

NORM 1: FETISHIZATION OF DATA PRECISION

The SPRU authors were justifiably critical of the numbers presented in *Limits*. Reading it fifty years later, one cannot help but bristle at the simplistic approach to certain calculations. Yes, we have better computers now. But the assumptions driving the math were also very rough. In my first year of grad school, I wrote a mediocre term paper showing how different approaches to population modelling produce wildly different estimates. I learned to account for changes in cohort-based birth rates, geographic variations in population change, and migration effects. But I found none of this in *Limits*. So, I can see how people with more training in econometrics would be struck by the lack of precision in the MIT modelling.

In retrospect, there is no doubt the basic projections in *Limits* were off by considera-ble magnitude. The MIT team projected a global population of 7 billion by 2002 (Meadows *et al.*, 1972, p. 38). The world population was approximately 6.27 billion at that time (World Bank, 2023). To make up the difference, the world would have needed at least two more United States; the total US population is (now) approximately 341 million (UN DESA, 2024). Or, put another way, the population estimate in *Limits* was off by about eight years: the global population reached 7 billion in 2010 (World Bank, 2023). Note, however, that the SPRU team was also incorrect in its population predictions. In the SPRU's chapter on population forecasting, William Page suggested the MIT figures would be underestimated. He argued that past attempts at long-term population forecasting have all been wrong. After reviewing past approaches to population modelling, he concluded that "it is impossible to know with certainty and accuracy a country's population over the long term future" (Cole *et al.*, 1973b, p. 172). He expected the MIT numbers would eventually prove to be just as inaccurate as past population forecasts. He was right. Anyone can now confirm that the projections in *Limits* were wrong. But those numerical outputs of the *Limits* model were not the primary concern at the SPRU.

Like other critics, the SPRU authors emphasized concerns about the data that supported and underpinned the structure of the World Model. This was most firmly stated by Cole and Curnow, who wrote: "since no firm empirical evidence is available, any relationship assumed in the model must be arbitrary" (Cole *et al.*, 1973b, p. 127). Here, they were focused on the relationships between pollution, agricultural production, and industrial production. Their word "arbitrary" was a clear rhetorical exaggeration; the SPRU team certainly agreed that relationships existed between these forces. But they disagreed with the MIT group about the *volume* of "persistent pollution" can be "absorbed" by the planet (Cole *et al.*, 1973b, p. 82). And so, they were not trying to say that the causal relationship was arbitrary. Rather, Cole and Curnow seem to have been making the point that the MIT team had not provided the empirical evidence normally expected when specifying an econometric model. This point recurs throughout the SPRU critique. The economist William Nordhaus (1973) took this further in his own response to *Limits*, saying: "without an accurate model there is no assurance that systems dynamics is better than mental models; the main result is a spurious and misleading precision" (p. 1157). In other words, they were saying that the precision of data moving through the model is unimportant if the relationships between elements of the model are not specified precisely and empirically.

The SPRU took this opportunity to call for better data. In summarizing problems with the MIT model, Cole and Curnow explained, "the database for the model is inaccurate, but not through any fault of Meadows and his colleagues... It is hoped that the MIT work will stimulate the collection of better statistics" (Cole *et al.*, 1973b, p. 109). This call for better statistics is resonant throughout the SPRU critique. The SPRU would go on to encourage and support the development of precise[2] datasets on sociotechnical change, especially through Freeman's relationship with the OECD (Fagerberg *et al.*, 2011; Soete, 2019). But the SPRU's concerns about data precision frequently sidelined important points in *Limits*. For example, Sinclair's chapter on environmentalism argues that pollution should be addressed as only a local concern, since there was no precise data on pollution at the global level. He argued that "there are so few reliable data on pollution... that attitude and judgment inevitably play a very large part in determining the assumptions that are made" (Cole *et al.*, 1973b, p. 176). And, with respect to the possible long-term climactic effects of pollution, he said, "even where modern predictions can be made for future physical levels of pollutants, technical uncertainty as to the effects of these is often such that firm recommendations cannot be made as to safe levels" (Cole *et al.*, 1973b, p. 180). Again, the SPRU team was agreeing that pollution is harmful. But they were also suggesting that the MIT group might be underestimating the amount of pollution that can be 'absorbed' or

[2] Fred Gault (2018; 2020) has shown that the resulting datasets are imprecise in their measurement of innovation.

otherwise mitigated by natural and socio-technical responses. They were suggesting that some indeterminate amount of pollution might be acceptable, and they were criticizing the lack of precision in the MIT estimates. There was no urgent need for global action but rather a need to collect more precise data.

The response to this from the MIT group was sharp. Meadows *et al.* accused the SPRU of "choosing to attack the straw man of perfection" (Cole *et al.*, 1973a, p. 221). They said that "instead of waiting for perfect models, society must work to construct and implement the best models possible today" (Cole *et al.*, 1973a, p. 73). And they explained the SPRU's obsession with precision as being driven by "a modelling philosophy that is directed primarily toward precise, short term prediction and is based on a reductionist view of the world" (Cole *et al.*, 1973a, p. 220). The MIT team clearly did not share the same cultural assumptions about modelling. They were attempting to provide an anti-reductionist model. They wrote: "the emphasis is meant to be not on the equations or the intricacies of the model, but on what it tells us about the world" (Meadows *et al.*, 1972, p. 23). They were trying to focus readers on the forest, not the trees. And yet, many critics pointed out that *Limits* was "very sensitive" (Vermeulen and de Jongh, 1976, p. 29) to small changes in those numerical details.

The SPRU's concerns about data precision cast doubt over the Meadows *et al.* (1972) conclusions. These same concerns also helped position the SPRU as a centre for expertise in the construction of datasets. As noted, Freeman already had a strong reputation and significant influence in shaping official statistical practices at the OECD (Godin, 2005). In the SPRU's next publication—the one that really launched its reputation for innovation studies—Freeman (1974) included a lengthy appendix on data measurement standards. That appendix would be dropped from later editions of *The Economics of Industrial Innovation* (Freeman, 1982; Freeman and Soete, 1997). And yet, interest in precise measurement would persist at the SPRU. The SPRU became tremendously influential in defining standards for data on science, technology, and innovation (Godin, 2005). In this way, the fetish for data precision became part of the disciplinary culture of innovation studies.

Norm 2: Toxic techno-economic positivity

The teams at the SPRU and MIT also had fundamentally different assumptions about how technological innovation should enter these models. Neither team was invested in the term "innovation" at that time. Instead, both teams wrote interchangeably of economic, social, political, and technological change. They both tended to emphasize the latter—the technology. But they were not in agreement about how it should be specified in a

model like this. In his introduction to the SPRU critique, Freeman explained that "technical changes are at the heart of our differences" (Cole *et al.*, 1973b, p. 10). He argued that "the MIT group is underestimating the possibilities of continuous technical progress" (Cole *et al.*, 1973b, p. 10). His colleagues Cole and Curnow repeated and broadened this sentiment: "the absence from the models of certain adaptive economic technological and social feedback processes is considered to be particularly suspect" (Cole *et al.*, 1973b, p. 108). Jahoda also concluded that the MIT model was missing "purposeful adaptive processes which continuously occur in the real world through political, social, economic and technological actions" (Cole *et al.*, 1973b, p. 213). Throughout their work, the SPRU team argued that adding such processes to the model would radically alter the results. For example, the SPRU team felt that adding technological change would mean that "any physical limits to agricultural production recede beyond the time horizon of the model" (Cole *et al.*, 1973b, p. 56). And, adding it across all dimensions of the model "has the effect of indefinitely postponing the catastrophes which the model otherwise predicts" (Cole *et al.*, 1973b, p. 10). The results of this technology-optimistic math lead Freeman to suggest that R&D—i.e., technological innovation—could serve as an "insurance policy" against the risk that the world might crash up against the limits to growth (Cole *et al.*, 1973b, p. 12). This was clearly not the view of Meadows *et al.* (1972).

Meadows *et al.* provided a different perspective on innovation in their reply. They asserted that they had not forgotten to account for technological innovation in their model (see Meadows *et al.*, 1972, pp. 48, 63). More clearly than any other text, the 30-year anniversary edition of *Limits* explains how certain technologies were built into the 1972 model: "health care, birth control, agricultural improvement, resource discovery and substitution" (Meadows *et al.*, 2004, p. 209). Other technologies were treated differently:

> They include resource efficiency and recycling, pollution control, unconventional increases in land yield, and land erosion control. When we first built the model, we didn't consider these technologies so established that they were technically proven and readily adopted by anyone in the world who could pay for them. We therefore programmed them so they could be activated as a discontinuous step at any simulated time that seemed reasonable to the model user. For instance, one could assume that the entire world would make a major commitment to recycling in 2005 or concerted effort against pollution in 2015. (Meadows *et al.*, 2004, p. 209)

Here, we see the specific difference in thinking that led to dramatically different mathematical approaches. The MIT team chose not to assume that technological innovation would be automatically triggered. In their response to the SPRU, they said, "we view technology as socially determined, discontinuous, infinitely varied, and delayed" (Cole *et al.*, 1973a, p. 233). They also elaborated their own model of technological innovation (Cole

et al., 1973a, p. 232)—and it had the kind of feedback mechanisms that would eventually appear in Kline and Roseberg's (1986) chain-linked model. The MIT team was also keen to point out that technology is not always a positive force for people or the planet. Overall, the evidence confirms that the MIT team had thought extensively about innovation.

So, it is on this basis that the MIT team criticized the SPRU team for its simplistic treatment of technological change. They said: "we cannot view it [technological change], as the Sussex group consistently does, as a cost free, purely beneficial, miraculous force that can repeal natural laws and rollback physical limits indefinitely" (Cole *et al.*, 1973a, p. 237). Somewhat sarcastically, they pointed out that it is unsurprising how exponential growth becomes possible when you introduce "exponential technologies" into the model (Cole *et al.*, 1973a, p. 226). It had been the SPRU's conclusion that human potential can "bend the imaginary exponential growth curves to gentler slopes than overshoot and collapse" (Cole *et al.*, 1973a, p. 211). Summarizing this SPRU position, Jahoda wrote that "man's inventiveness in changing social arrangements is without limits even if not without hazards" (Cole *et al.*, 1973a, p. 215). In this way, the SPRU was arguing that the MIT team should have built faith in technology into the model.

Thirty years later, the remaining members of the MIT team would continue to reject this argument, saying that,

> It is true we did not include in the original World3 model technological progress at rates that would automatically solve all problems associated with exponential growth in the human ecological footprint. That was because we did not—and still do not—believe such tremendous technological advance will occur by itself, nor through the unaided operation of 'the market.' (Meadows *et al.*, 2004, pp. 203-204)

In other words, they saw no place in their model for this kind of faith in technical change. Indeed, they remained concerned about mathematical renderings of this faith. Meadows *et al.* (2004) said,

> For many economists technology is a single exponent in some variant of the Cobb-Douglas production function—it works automatically, without delay, at no cost, free of limits, and produces only desirable outcomes. No wonder economists are so rapturous about its potential to solve human problems! (Meadows *et al.*, 2004, p. 210)

The SPRU team was not exclusively full of economists. And Freeman only briefly mentions a Cobb-Douglas function in his response to *Limits* (see Cole *et al.*, 1973a, p. 77). Nonetheless, these arguments speak to the epistemic differences between the two camps. The SPRU and MIT teams could not agree because they viewed—and modelled—technological change differently.

This aspect of their disagreement would lead the MIT team to being labelled as anti-technology. Meadows, Randers, and Meadows would later say, "if we suggest that technology or markets have problems or limits, some will consider us to be heretics, and they will say that we are anti-technology" (Meadows *et al.*, 2004, p. 205). Indeed, Kahn *et al.* (1976) expanded on the arguments from SPRU and further characterized *Limits* as anti-technology. They described the MIT team's "neo-Malthusian" position as the polar-opposite of any "technology and growth enthusiasts" (Kahn *et al.*, 1976, p. 10). This contrast established a straw man position: the group from MIT became the adversaries of technology-because they were adversaries of unbridled growth. Notice the entanglement of technology and growth. Also notice the irony. The *Limits* team was situated in one of the USA's most important institutions for technology. The project was initiated by Forrester—a highly accomplished engineer who held patents on key computer and defense technologies (Lane, 2007; Ramage and Shipp, 2009). The MIT team was not anti-technology (Vieille Blanchard, 2015).

The MIT team was not even pessimistic. In a documentary film about their work and this debate, Dennis Meadows and Bill Behrens both express the surprise they felt at having been called pessimists. Behrens says, "At that time we were all optimists. Every single one of us believed that the research that we were doing and the book that we were writing was a prescription for optimism" (Enrico, 2013, starting at 27:10). Indeed, this self perception is confirmed in footage from the *Limits* book launch event in 1972. Donella Meadows said, "I'm very hopeful in this country that the mechanisms do exist for this kind of cultural change. In fact, I think it's already happening" (Enrico, 2013, starting at 26:15). And so, I have no doubt that the MIT team was hopeful and optimistic that *Limits* would inspire innovation. It was spurious to call them pessimistic.

Conversely, I would argue that the SPRU team was advocating a toxically positive perspective on innovation. Toxic positivity is an extreme form of positive or optimistic thinking that denies negative realities and emotions. In the late 1970s, Neil Weinstein (1980) studied a phenomenon that he called "unrealistic optimism about future events" (p. 806). Later, Jack Halberstam (2011) called this "toxic positivity" (p. 3). It is a cultural norm where people who express negative emotions or concerns are quickly redirected to focus on the bright side (Ehrenreich, 2009; Halberstam, 2011). This is the kind of push-back Meadows *et al.* (1972) received from the SPRU and then from others, like the Hudson group. The negative effects of growth they had highlighted were sidelined by arguments and mathematical adjustments that positioned technology as an overwhelmingly positive cure. The father of ecological economics, Nicholas Georgescu-Roegen, sarcastically caricaturized this aspect of the SPRU's work:

> Should we run out of some resources, we will always think up something, just as we have continuously done since the time of Pericles. Nothing, therefore, could ever stand in the way of an increasingly happier existence of the human species. (Georgescu-Roegen, 1975, p. 360)

For their part, the SPRU team admitted that some of their changes to the modelling "could be criticised as being over-optimistic" (Cole *et al.*, 1973a, pp. 130-131). They argued that this over-optimism was a justified antidote to the pessimistic assumptions in *Limits*. But it was not.

In hindsight, present-day SPRU researchers have noted that their predecessors' techno-optimism, "has not aged well" (Smith and Ely, 2025, p. 237). Consider some of the specific technologies that the SPRU team presented as justification for their mathematical optimism. They asserted that "it is not unreasonable to expect that within 30 years a breakthrough with fusion power will provide virtually inexhaustible cheap energy supplies" (Cole *et al.*, 1973a, p. 103). Fifty years later, we still do not have workable fusion power. And, "the running joke is that engineers have been saying it's a decade away for about six decades now" (Hickel, 2020, p. 145). But the SPRU team argued that "should this breakthrough take longer, pessimism would still be unjustified" because we would still have "nonconventional hydrocarbons" to extract (Cole *et al.*, 1973a, p. 103). This is where the SPRU arguments became the most environmentally toxic.

A page and a half of the SPRU text is dedicated to the possibilities (and technological challenges) of developing the Alberta oil sands, similar heavy oil deposits in Venezuela, oil shales, "and the conversion of coal to oil and gas" (Cole *et al.*, 1973a, pp. 103-104). In hindsight, we know that the extraction of these nonconventional hydrocarbons has been extremely damaging to the planet (Rosa *et al.*, 2017). We could excuse the SPRU team for not knowing this in the 1970s; hydrocarbon projects like these have long been the subject of rhetorical promises and green-washing (Katz-Rosene, 2017). But the key point remains: the SPRU team was excessively optimistic about the promise of technology to drastically extend growth. They were using specific technologies like fusion power and nonconventional hydrocarbon development as exemplars of other promising, yet-to-be-developed technologies. These examples were support for the argument that some indeterminate future socio-technological changes should be assumed within the model. Jason Hickel caricatured arguments like this, saying:

> It's like jumping off a cliff while hoping that someone at the bottom will figure out how to build some kind of device to catch you before you crash into the rocks below, without having any idea as to whether they'll actually be able to pull it off. (Hickel, 2020, p. 128)

My own conclusion will draw fewer laughs. This is because I am less concerned with the specifics of the SPRU's techno-optimism. I am more concerned with the lasting normative effects.

Much has been written about techno-optimist (or sometimes "Promethean") arguments (e.g., Danaher, 2022; Hornborg, 2024; Keary, 2016; Königs, 2022; Krier and Gillette, 1985). John Danaher (2022) has summarized a variety of these techno-optimist positions, and their criticisms. In simple terms, he defines techno-optimism as "the view that technology, when combined with human passion and ingenuity, is the key to unlocking a better world" (Danaher, 2022, p. 2). This definition is consistent with the perspective expressed by the SPRU team in *Models*. They argued that technology cannot fix all ills (Freeman and Jahoda, 1978, p. 389), but that "sustainability could be achieved by reorienting the R&D system and through major institutional change" (Stern and Valero, 2021, p. 2). Danaher (2022, pp. 3-4) says that all varieties of techno-optimism and pessimism involve taking a "stance" or committing to a viewpoint like this. But what happens when that viewpoint is translated into statistical techniques and methodological norms?

Others have already noted that the SPRU were first to take a techno-optimistic, "Promethean," or "cornucopian" stance against *Limits* (see Icassatti Corazza *et al.*, 2015; Keary, 2016; Vieille Blanchard, 2015). This was expressed in both writing and mathematical modelling. Others would join the chorus with slightly different optimistic perspectives. But I agree with Krier and Gillette (1985) that, overall, the techno-optimist critiques of *Limits* were about more than a commitment to exponential growth and innovation. These critiques also involved ignoring the degree to which some innovations are bad for people and the planet (Krier and Gillette, 1985). Retrospectively, some might call this a "pro-innovation bias" (Godin and Vinck, 2017a). But the term "innovation" had not yet entered the conversation. Indeed, this was only the beginning of the scholarly efforts that would establish innovation studies as a discipline (see Fagerberg *et al.*, 2013; Godin, 2017; MacNeil, 2024; Soete, 2019). As I have said from the outset: the SPRU's work here was the groundwork for long-term organizational and disciplinary norms. So, I propose that this was something more than a one-time stance or bias. This was toxic positivity. Before its first publications about innovation, the SPRU was establishing arguments and mathematical techniques that made complex, techno-critical, degrowth perspectives appear irrational. The norm would be to model innovation from only a positive perspective.

CONCLUSION

This paper has contributed to the intellectual history of innovation studies by examining the methodological practices that were developed and employed in the early days of the Science Policy Research Unit. The SPRU is well-known for its members' many positive contributions to innovation theory and policy (see Fagerberg *et al.*, 2011; Soete, 2019). Less consideration has been given to the SPRU's participation in the *Limits to Growth* debate. Present-day SPRU researchers, Smith and Ely (2025), recently looked at this with an eye for its impacts on the international politics of technology. But most of what has been written situates *Models of Doom* (Cole *et al.*, 1973a, 1973b; Streatfeild, 1973) as the techno-optimist turning-point in the *Limits* debate (Higgs, 2014; Vieille Blanchard, 2010; Vieille Blanchard, 2015). None of this is well studied in STS (Sharma *et al.*, 2025). In this paper I have argued that the SPRU team's work here helped establish norms for the emerging fields of innovation research and policy. I will now conclude with some discussion of my methodological limitations (and contribution), the intellectual contribution of this paper, and future research directions.

METHODOLOGICAL LIMITATIONS AND CONTRIBUTION

I took a critical ethnostatistics approach to this key moment in innovation scholarship. As one excellent reviewer pointed out, ethnostatistics (Gephart, 1988, 1997, 2006) is a scantly used approach and my work here extends its scope considerably. Ethnostatistics was developed within organization studies but has had limited use even there. A few critical management scholars have deployed it to problematize the assumed objectivity of organizational statistics (e.g., Boje *et al.*, 2004; Helms Mills *et al.*, 2006; Smith *et al.*, 2004). At the intersection with innovation studies, Kilduff and Oh (2006) used ethnostatistics to surface the assumptions inside four conflicting analyses of the same medical innovation diffusion data. And in my book, *Observing Dark Innovation* (MacNeil, 2024), I fused ethnostatistics with autoethnography to understand neoliberal norms of innovation quantification. There, I criticized ethnostatistics for often employing the "god trick" (Haraway, 1988) of providing seemingly distanced description of 'others' statistical work. Indeed, that classic criticism of ethnography could be applied to this paper. But I have attempted to remediate this aspect of ethnostatistics by injecting critical reflexivity. This is why my voice and politics surfaced frequently throughout this paper. By now it should be clear that this project was motivated by personal ecological values, a post-growth positionality, and a concern for deconstructing counterproductive disciplinary norms (see also, MacNeil, 2024). In this way, my approach to ethnostatistics is closer to other styles of sociological

quantification studies (see Lippert and Verran, 2018). It differs in its direct focus on statistical methods as evidence of cultural norms.

To some extent, I have inverted the research question that was asked forty years ago by Brian Bloomfield (1984). In one chapter of his PhD thesis, Bloomfield compared the modelling approaches of the SPRU and MIT teams to better understand norms in the emerging field of system dynamics. His thesis was written before the term "ethnostatistics" was coined. But he called his work "ethnographic" (p. 85) and he was interested in the "professional cosmology" (p. 85) of "system dynamicists" at MIT. In my case, I was interested in the professional norms that were being established by the early innovation scholars at the SPRU. In both cases, he and I have relied on published traces of past scholarly activity. No one is able to produce ethnographic "thick description" (Geertz, 1973) of the past without access to a time machine. We can only work from traces. This is where a critically- and historically- conscious ethnostatistics reveals its greatest limitations, but also its utility. It cannot provide a full ethnographic description of the past, but it is useful for the deconstruction of long-standing methodological/disciplinary norms.

INTELLECTUAL CONTRIBUTION

In this paper I found that both the MIT and SPRU teams agreed on the fundamental fact that planetary limits exist. However, they fundamentally disagreed about how these limits should be approached. I have examined two aspects of their disagreement.

First, I explored how the SPRU team criticized the lack of data precision in *Limits*. For many dimensions of the MIT model, the SPRU team noted the lack of high-quality data and dismissed the surrounding arguments. I have suggested that this amounted to a fetish for data precision. The fetishization of data precision extended beyond this debate as the SPRU was quickly developing influence and a reputation for building datasets and data standards. But my conclusion here should not be read as an argument for statistical anarchy or the abandonment of all modelling. It is only a further call for methodological humility (Law and Singleton, 2005, p. 350; MacNeil, 2024, p. 147). No degree of data precision can build a time machine or crystal ball.

I have also described how the SPRU team was simultaneously arguing that *Limits* ought to have taken a very imprecise approach to socio-technical change. The SPRU arguments helped falsely position the MIT team as anti-technology. They made the exaggerated argument that technology had been left out of the *Limits* model. The SPRU's techno-optimist arguments were then presented as a more realistic approach. And in their own

math, the SPRU team demonstrated that the limits to growth will extend beyond our current time horizon if we assume greater technological advancement. This approach made any natural limits fade asymptoticly into the future. Here, they were advocating mathematical faith in technological change. There are a variety of terms that might apply here, such as "techno-optimism" (Danaher, 2022; Königs, 2022; Krier and Gillette, 1985), "techno-solutionism" (Sætra, 2023), or "Prometheanism" (Hornborg, 2024; Keary, 2016). But these existing labels are focused on researchers' attitudes or stances toward technology. These are positions one might take in a debate. The concept of "toxic positivity" (Halberstam, 2011) shifts our focus toward a cultural norm that shapes other people's attitudes or stances. It defines the realm of possible and acceptable attitudes, stances, and arguments. I see this as an important new shift for post-growth thinking in STS and critical studies of innovation. I am proposing the concept of "toxic techno-economic positivity" as a critical interpretive key that may help further disentangle innovation from growth.

What I am not trying to do here is attack the SPRU. The team that wrote *Models* agreed that "exponential growth of population and industrialization on a finite planet cannot continue indefinitely" (Cole *et al.*, 1973b, p. 22). And so, I am not saying that the SPRU team meant to undermine the main point of *Limits*. There is no doubt about their deep concern for people and planet. Chistopher Freeman was a life-long environmentalist (Stern and Valero, 2021). I believe that he and the entire SPRU team wanted readers to 'focus on the positive.' They wanted their readers to have faith in human capacities for positive change. This is laudable. But this also had unintended, toxically positive effects. It set the stage for disciplinary norms focusing almost exclusively upon the 'bright side' of technological innovation. It suggested to scholars, policy makers, and other readers, that they need not worry about the limits to growth if they instead focus on the promise of technological innovation.

FUTURE DIRECTIONS

Both *Limits* and *Models* clearly state that mathematical modelling is a cultural and political activity. In *Models*, Freeman said, "it is essential to look at the political bias and the values implicitly or explicitly present in any study of social systems. The apparent detached neutrality of a computer model is as illusory as it is persuasive" (Cole *et al.*, 1973b, p. 7). I agree. In this paper, I have demonstrated how insights into the culture of innovation modelling can be surfaced by using a critically- and historically-conscious approach to ethnostatistics. This method has future potential for critical studies of innovation.

There are also several lines of future inquiry that arise from this paper. Because I was focused on disentangling the innovation-growth dyad, I did not explore the MIT team's arguments that the SPRU researchers had taken a very anthropocentric view of technological change. This can be found in the MIT response appended to Cole *et al.* (1973a) and in Meadows *et al.* (1973). I also did not explore concern from the SPRU over inequities between the Global North and Global South. This was the primary focus of another detailed critique of *Limits*—by the Argentinian Bariloche Foundation (Herrera, 1977). The SPRU critique of *Limits* had also included multiple claims that the MIT team was working in the interests of the global elite. This concern for global inequities does carry forward into future research at the SPRU. Smith and Ely (2025) have recently published an excellent contribution along this line of inquiry. More work is needed in decolonizing innovation studies.

My concern here has been with the ways that innovation research and policy came to believe the mantra: "not to innovate is to die" (Freeman, 1974, p. 256). In *Models*, the SPRU researchers expressed this belief in both a mathematical and a planetary-existential sense. I have shown how they argued against the *Limits* to Growth by pointing to the lack of precision in the mathematical modelling. But I have also shown how they also ignored this desire for precision and advocated mathematical faith in technological fixes. Unfortunately, this helped redirect attention from very real planetary limits—which, admittedly, the MIT team had miscalculated. *Models of Doom* suggested that scholars and policy makers could redirect their attention to the bright spots of technological innovation. I have called this redirection toxic techno-economic positivity, and I have argued that it persists today inside the epistemic culture of innovation research and policy.

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Innovationism between Art and Technology

Technological determinism in the controversy around Vantablack

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ABSTRACT

This article investigates how innovationism—the neoliberal paradigm framing technological innovation as a profit-driven imperative—structures the sociotechnical controversy surrounding Vantablack. Through an STS lens, we analyze how Surrey NanoSystems, Anish Kapoor, and Stuart Semple mobilize contradictory narratives that simultaneously critique and reproduce innovationist ideologies. While the material's development as a nanotechnology-based "superblack" pigment exemplifies technological determinism (treating Vantablack's emergence as an autonomous scientific breakthrough), its artistic appropriation reveals co-produced tensions between market logics and cultural production. The actors' practices demonstrate innovationism's paradoxes: Surrey NanoSystems oscillates between high-tech branding and low-end commercialization; Kapoor leverages exclusivity despite achieving similar aesthetic effects through conventional means; Semple's democratizing rhetoric relies on the same novelty-seeking mechanisms he condemns. These contradictions emerge from a shared ideological framework that naturalizes innovation as both economically necessary and socially neutral, obscuring its role in reinforcing asymmetries of access and power. We argue that the Vantablack controversy crystallizes broader tensions in technoscientific governance, where innovationism mediates between art, technology, and politics. Rather than resolving these tensions, the case exposes how even competing positions remain constrained by market-centric epistemologies that privilege short-term profitability over collective benefit. The study advances critical perspectives on innovation by unpacking its material, discursive, and ideological dimensions in contested cultural domains.

Keywords: Innovationism; Technological Determinism; Art and Technology; Vantablack; Nanotechnology.

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INTRODUCTION

In 2016, when the controversy surrounding Vantablack entered the art world, the various positions of the actors involved, along with media commentary, highlighted a significant observation: artists do not have access to all colors. This observation challenges assumptions about the chromatic phenomenon that are often taken for granted. Typically, colors are viewed as immaterial and readily available, aided by commercial color charts[1] and digital tools. However, this controversy reveals the materiality and limitations of color.

Despite the widespread opinions and research on the issue, there has been a lack of necessary connections between the multidisciplinary debates surrounding the subject. It is crucial to draw upon insights from Science and Technology Studies (STS), a critical perspective on technoscience, color theory, and social theory, particularly focusing on the intricate relationships between art, economics, politics, and policy.

With these perspectives in mind, our research frames the debate around a specific issue: the role of innovationism in the Vantablack controversy. This neoliberal model of invention, which prioritizes short-term profit as the primary goal of scientific and technological development, plays a pivotal role in the interactions we have studied. Our overarching aim is to understand its impact on the primary actors involved: Surrey NanoSystems, Anish Kapoor, and Stuart Semple.

We identify innovationism as a driving force behind nanotechnology inventions like Vantablack. The uncertainty surrounding its commercial viability creates a connection with mass audiences, relying on the spectacular presentation of futuristic promises. The invention of Vantablack is self-justified by its emphasis on novelty and short-term profit. This innovationist logic extends into the contemporary elite art world, where production is similarly driven by novelty and profit. As we will present, Kapoor's use of a challenging and expensive material like Vantablack to achieve an aesthetic result he had previously attained is justified by the values of exclusivity, luxury, and innovation associated with the material. Meanwhile, Stuart Semple's reaction, while also aiming to create a superblack material, frames the controversy differently, emphasizing innovation without the luxury and exclusivity of Vantablack. In conclusion, innovationism plays a central role in shaping how Vantablack is contested and enacted by these competing actors and their associated values. These practices and narratives are rooted in a deterministic view of technology, seeing it as separate from society and as the key driver of social transformation.

[1] Color charts are systematic visual representation of colors, often used to aid in color selection, identification, or understanding of color relationships.

To study this subject, we build on the sociotechnical controversy surrounding Vantablack, which we previously mapped in our doctoral research using the frameworks proposed by Bruno Latour and Tommaso Venturini (Venturini, 2010). Drawing on news reports, catalogs, scientific surveys, interviews, and statements from key stakeholders, this study examines the sociotechnical network underpinning the controversy surrounding Vantablack. The primary actors in this dispute include Surrey NanoSystems—the creators and owners of Vantablack—along with lead scientist Ben Jensen, as well as artist Anish Kapoor, who holds exclusive rights to its artistic use. Opposing this arrangement is Stuart Semple and his company Culture Hustle, which has developed alternative pigments such as Pinkest Pink and the Black 1.0–4.0 paint series in explicit protest against Kapoor's monopoly. We draw upon STS definitions of innovationism, particularly the critical perspectives offered by Oliveira (2011), Bagattolli (2013), Serafim and Dias (2015). Additionally, contributions from Cupani (2011) enable us to connect the themes of innovationism with technological determinism, the neutrality of technology, and neoliberalism.

In this text, we provide a brief overview of the Vantablack controversy, its main topics, and key actors. We then present some theoretical assumptions and concepts that underpin our analysis. Subsequently, we explore how innovationism influences the framing of each of the three primary actors—Surrey NanoSystems, Anish Kapoor, and Stuart Semple. Finally, we offer our concluding remarks.

1. CONTROVERSIES AROUND VANTABLACK

In 2014, British nanotechnology company Surrey NanoSystems developed a novel pro-duct intended for use in telescopes and with potential military applications. Composed of carbon nanotubes, this material has the unique ability to absorb light, rendering any object coated with it nearly invisible, akin to a void. 'Vertically Aligned Nanotubes Array Black', or Vantablack, is a superblack material that absorbs almost all light, with a reflec-tion rate of just 0.036% (Michael, 2018).

The product's debut got significant media attention, with commentators using metaphors such as "You must not see it to believe it" (Cascone, 2014) to emphasize its seemingly otherworldly properties. Its appearance as a black void evoked comparisons to phenomena like black holes. From the outset, Surrey NanoSystems anticipated the material's potential applications beyond its optical and military uses, suggesting that it could be employed in luxury goods, cinematography, and architecture (Michael, 2018). However, despite its striking visual qualities, the company did not initially foresee its use

in the art world. It was only after the British-Indian artist Anish Kapoor contacted them in 2015 that a version of Vantablack was adapted for artistic purposes.

The collaboration between Surrey NanoSystems and Kapoor unexpectedly stirred controversy within the artistic community. Their agreement granted Kapoor exclusive rights to use Vantablack for artistic purposes, a decision that outraged many other artists who were eager to work with the material but were barred from doing so, regardless of their willingness to pay for it. Painter Christian Furr stated that he had never heard of an artist monopolizing a material, while watercolorist Shanti Panchal described such behavior as "absurd" (Renard, 2016). These reactions prompted British artist Stuart Semple to formulate a response that extended beyond mere discourse. In 2016, Semple became the first to take concrete action by developing his own ultra-black paint. His product, Black (now in its Black 4.0 version), is made from acrylics, making it non-toxic and affordable. However, Semple's paint is sold with a unique condition: purchasers must confirm online that they are not Anish Kapoor, as Semple's products are available to everyone except his artistic rival.

Following Semple's intervention in the debate, Surrey NanoSystems and Kapoor recalibrated their strategic framing of Vantablack. In a statement posted on their official Twitter account, Surrey NanoSystems asserted that "Vantablack is not a colour, it's the complete absence of colour" (Breitenbach, 2016). This declaration introduced fundamental ambiguities regarding Vantablack's ontological status: was it truly a color, or rather a material phenomenon? Such questions precipitated deeper theoretical inquiries into the very nature of color—what constitutes a color, whether color can be proprietary, and by what criteria such determinations should be made. Surrey NanoSystems' position effectively reframed the discourse, arguing that because Vantablack represented the absence rather than presence of color, its exclusive control was justifiable across moral, political, technical and legal dimensions. Thus, what began as a dispute over artistic access escalated into a significant epistemological debate challenging conventional understandings of color theory and material production.

The controversies surrounding Vantablack are sociotechnical in nature. Debates in scientific knowledge always relate to broader social and political issues. These disagreements have historical trajectories that intertwine with the development of modern scientific method, becoming an inevitable part of relations between science, politics and society (Turnhout; Tuinstra; Halffman, 2019). Controversies usually reveal aspects that normally stay hidden, leaking beyond the scientific field and involving other social actors (Venturini, 2010).

Actors that perform a mediation role in the controversy, that are responsible for transformations and influence over the key elements of the sociotechnical network, we consider as primary (Lourenço; Tomaél, 2018). We identify them as Surrey NanoSystems, Anish Kapoor and Stuart Semple, as well as Vantablack itself.

To make Vantablack commercially viable, Surrey NanoSystems positioned it as a sophisticated technology, a professional-grade art material, and an innovative perception device. At the same time, however, the company formed connections with industries as diverse as deodorants, video games, the automotive sector (e.g., BMW), and luxury watchmakers like H. Moser (Surrey NanoSystems, 2021). These varied applications required technical modifications, resulting in multiple versions of Vantablack. For satellites, the Vantablack S-IR is used in infrared instrumentation (3μm to 25μm) for space and terrestrial applications. For telescopes, the Vantablack S-VIS superblack is optimized for space use. In the automotive industry, the VBx2.3 version of Vantablack, designed for Automotive ADAS Stray Light Suppression, reduces diffuse light in vehicle sensors. This version, which is applied via spray and absorbs 0.9% of visible light, is also the one used by Anish Kapoor.

In response to public backlash and the actions of other stakeholders, Surrey NanoSystems adjusted its communication strategy and production processes. Kapoor also had to adapt his artistic intentions, as Vantablack proved to be more technically challenging than he had anticipated, and his use of it was subject to scrutiny from a critical artistic community. Meanwhile, Semple's involvement in the controversy brought him considerable attention, allowing him to found his own color company, Culture Hustle, in 2016. This development shifted his career trajectory, increasing his success and positioning him as a figure who combines artistic practice with entrepreneurship, social media engagement, and polemical self-promotion, an interesting career strategy for an independent artist in the competitive art market.

The controversies surrounding Vantablack reveal deeper connections to a broader process of invention-driven scientific and technological development, oriented toward short-term profit. These issues intersect with technological determinism, neoliberal ideology, and the assumption of technology's neutrality. After outlining our methodological approach and theoretical assumptions in the next section, we explore how innovationism has influenced the actions and relationships of the primary actors in this controversy.

2. VANTABLACK'S CREATION AND KEY CONCEPTS OF ANALYSIS

Innovation narratives play a significant role in shaping how the actors involved with Vantablack frame the material. According to the Surrey NanoSystems website, "Vantablack is the name of a brand for a new class of superblack coatings" (About Vantablack, 2023). In an interview, Anish Kapoor discussed his use of "the newly developed pigment Vantablack" (Bronner, 2015), while reports describe how "Anish Kapoor Adds New 'Super Black' to His Palette" (Cascone, 2014). Whether referred to as a coating, pigment, or color, Vantablack is consistently associated with the concept of 'newness.' It is described as a new application of carbon nanotubes, a new technology, an unprecedented optical property, and a new kind of black.

The concept of technological innovation is often shrouded in mystification. Histories of technology tend to emphasize breakthroughs and inventions, often overlooking pre-existing techniques, which are treated as unquestioned elements of progress. These dominant narratives present technological development as linear and cumulative, embedded in the notion of continuous progress. Such a conception is problematic because it fails to distinguish between innovation and usage, ignoring the specific historical and spatial contexts of invention processes (Edgerton, 2004).

This kind of mystification can be challenged by examining the development of Vantablack more closely. Scientific research on superblack coatings began as early as 2007 (Dury *et al.*, 2007), and studies on the spatial applications of superblack coatings were published in 2013 (Hagopian, 2013). Investigations into the optical uses of carbon nanotubes followed in 2015 (Azoubel *et al.*, 2015). After Vantablack's release, other companies developed similar products. In 2017, Nanolab, a U.S. laboratory associated with NASA, produced a carbon nanotube-based superblack coating called AdVANTA Black. In 2019, MIT created its own nanotechnology-based superblack, known as Ultrablack CNT.

The production of Vantablack requires complex and expensive infrastructure. The process involves a specialized reactor that chemically induces the growth of millions of tiny carbon filaments, known as carbon nanotubes, which are responsible for the material's light-trapping properties (Threewitt, 2021). Vantablack is a fragile material that cannot withstand open environments or direct contact with mechanical abrasion. Like many nanotechnologies, it is also potentially toxic (Michael, 2018).

Vantablack's primary appeal lies in its visual effect—its total opacity and flat, texture-masking blackness. However, carbon nanotubes are not a new discovery. They were first created in 1991 by Japanese physicist Sumio Iijima, who identified their extraordinary tensile strength (Real Engineering, 2021). The novelty of Vantablack lies in the use of carbon nanotubes in optics and the exploration of their ability to absorb electromagnetic energy, including visible light.

In addition to its discursive importance, innovation has become a policy model (Bagattolli, 2013) and a central concept within neoliberal technoscientific frameworks (Oliveira, 2014). According to Langdon Winner (2018), the term innovation functions as a "god term"—a concept perceived as inherently positive and a driving force of development. Although historically linked to the modern ideology of progress, today's dominant discourse frames innovation primarily in market-centered terms.

The criteria for evaluating innovation no longer hinge on social benefit but rather on profitability. Consequently, this form of progress does not guarantee collective advancement but instead benefits a select few—namely, those with capital to invest. Winner (2018, p. 67) argues that innovation has thus become the "jewel in the crown of neoliberalism," reflecting a shift from earlier ideals of universal betterment toward a model that privileges privatization, deregulation, and private-sector solutions over public welfare. Within this framework, improvement is presumed to emerge incrementally through market-driven innovations, supplanting collective efforts toward the common good in favor of individual and corporate gains.

Following these notions, scientific activity is now primarily oriented toward producing technological innovations, which are defined as inventions that reach the market and generate short-term profit. This phenomenon, known as innovationism, promotes the commercialization of science in line with neoliberal agendas (Oliveira, 2011). Innovationist policies focus on creating the infrastructure necessary for companies and scientific institutions to innovate, dynamically reorganizing connections between social and market actors in a systemic approach (Bagattolli, 2013).

The innovationist model positions technological innovation as the engine of economic growth and views new technologies as the primary drivers of social change, aligning with the concept of technological determinism. This concept suggests that technological development is the determining factor in social transformation, following a linear model in which more innovation automatically leads to greater social progress. In this framework, technology is seen as autonomous, operating independently of human

influence. According to technological determinism, technological progress is inevitable, continuous, and self-directed, driven solely by efficiency and divorced from political or moral considerations (Cupani, 2011).

The emphasis on innovation in policy leads to institutional arrangements that link scientific institutions, such as universities, with market-oriented stakeholders, such as companies in the productive sector. This interaction fosters an entrepreneurial culture that naturalizes innovation as the primary objective of research, shifting the goals of non-market organizations toward commercialization (Serafim and Dias, 2015). Alternative criteria for scientific and technological development, including ethical considerations, are marginalized, consolidating a view of science and technology as neutral and inherently beneficial.

Thus, key concepts such as innovation, innovationism, technological determinism, the neutrality of technoscience, and neoliberalism are interconnected within a system of scientific and technological practices and narratives. As a result, scientific and technical agendas are increasingly directed toward short-term, profit-driven innovations. In line with neoliberal theory, market processes become the primary forces shaping social activities.

To explore the role of innovationism in the Vantablack controversy, we analyze how each actor frames the product. These framings involve decisions about what aspects of the product's representation—its images, metaphors, and narratives—are included or excluded. Framings are also articulated through objects and actions, such as measurement equipment, research practices, political issues, and long-term institutional structures (Turnhout, Tuinstra, and Halffman, 2019). The controversy surrounding Vantablack's nature reflects different framings by various actors, including their treatment of its nature, partnerships, and agency. Analyzing these framings allows us to better understand the role of innovationism in the Vantablack controversy as a whole.

3. SURREY NANOSYSTEMS, INNOVATIONISM AND NANOTECHNOLOGY

In 2016, two years after its creation, Vantablack was featured on BBC's The One Show, where it was likened to a black hole. Presenter Marty Jopson demonstrated its non-reflective properties by shining a flashlight on it, remarking that Vantablack "has the potential to revolutionize our understanding of the universe" (Onetruechannel, 2016). In both verbal and visual representations, Vantablack was portrayed by its creators as a highly sophisticated, futuristic innovation developed using advanced tools, such as a

specialized reactor, in a pristine laboratory environment evocative of settings seen in science fiction movies.

These representations frame Vantablack as a refined and exclusive technological object. However, subsequent partnerships formed by Surrey NanoSystems introduced actors from diverse, and often contrasting, sectors. Some of these partners are linked to the luxury market, such as the Swiss watch brands MCT and H-Moser, which produced luxury watches featuring Vantablack in 2016 (Fenner, 2016), and BMW, which produced a single model entirely coated in Vantablack for the 2019 Frankfurt Auto Show (Koenig, 2019). On the other hand, partnerships with more mainstream and mass-market actors also emerged, including the popular deodorant brand Lynx, which covered a bottle in Vantablack for exhibition in 2016, a pavilion built for the Winter Olympic Games in South Korea (Surrey NanoSystems, 2022), a promotional event for the video game Call of Duty: Black Ops 4 in 2018 (Kelly, 2018), and stage designs for French DJ Gesaffelstein in 2019 (Deahl, 2019).

These seemingly disparate collaborations can be better understood by examining Vantablack's relationship to innovationism. Vantablack is not merely a technology but a nanotechnology, which carries significant implications. The primary criterion for defining nanotechnology is its scale. According to the U.S. National Nanotechnology Initiative, nanotechnology involves the manipulation and control of matter at dimensions of approximately 1 to 100 nanometers[2] (Barben *et al.*, 2008).

Over the past thirty years, research and applications in nanotechnology have made significant advances in fields such as pharmaceuticals, electronics, materials engineering, and optics. Nanotechnology has grown alongside biotechnology, information technology, and cognitive science. Despite these advancements, nanotechnology is not a well-defined field, as it is not approached in a linear or disciplinary manner. This lack of clarity underscores the importance of promoting public acceptance and the feasibility of nanotechnology by propagating positive images of its development. As nanotechnology enters into public discourse, often politically charged, a strong polarization has emerged. There are optimistic interpretations, which herald nanotechnology as revolutionary, and pessimistic ones, which raise concerns about its potential risks (Mattedi *et al.*, 2011).

[2] For comparison, the average thickness of a human hair is 80,000–100,000 nm (0.08–0.1 mm), making nanomaterials at least 800 times smaller than a hair's cross-section.

These opposing perspectives are evident in the controversies surrounding Vantablack. Just as nanotechnology is hailed by its proponents as revolutionary, Vantablack is presented as capable of creating a new color and a novel visual experience, often described as "the blackest material in the universe" (Batycka, 2022). Conversely, critics, such as Stuart Semple, emphasize the risks associated with nanotechnology and highlight that, in contrast, his own black paint is non-toxic and does not require state approval for purchase.

Innovation in nanotechnology often focuses on future possibilities, with significant emphasis placed on the representations of its potential. As Mike Michael (2018, p. 1107) notes, in the case of Vantablack, "its full aesthetic potential is not necessarily self-evident but must be mediated through artistic practice." The various demonstrations conducted by Surrey NanoSystems with partners such as Lynx, BMW, and Anish Kapoor serve to show us what Vantablack looks like more than what Vantablack is able to do (Michael, 2008).

> The main point to draw out here is the uses (or viability) that are associated with VANTAblack largely do not exist in the present (cf. Collins's case study where the demonstration aimed to establish the current safety of the flasks) but in the future (i.e., prospective applications). Aesthetic experience thus serves in the assessment of potentiality or promise: it is another means of enacting expectations (see Borup *et al.*, 2006). (Michael, 2008, p. 1112)

The uncertainties surrounding the product's initial applications, coupled with its high cost and complex production process, prompted Surrey NanoSystems to seek short-term profitability. In addition to building an audience based on future promises, as explained by Michael, the diversity of partnerships also helped the company identify immediate commercial opportunities.

The partnerships cultivated around Vantablack strategically harness both the product's novelty and the cultural authority of nanotechnology, capitalizing on the pervasive assumption that technological innovation represents inevitable progress. Through carefully crafted media presentations that emphasize technical achievement over social context, Surrey NanoSystems reinforces a worldview that frames Vantablack's development as an autonomous, unavoidable outcome of scientific advancement rather than as a contingent product of corporate strategy.

For public audiences, this framing reduces complex innovation processes to spectacular demonstrations of technical inevitability. By presenting Vantablack's existence as simply the next logical step in material science, all sociopolitical considerations regarding its development costs, accessibility, and social utility become obscured behind an apparently predetermined trajectory of technological progress.

Nanotechnology's significance in the paint and color industry stems from its ability to produce structural or physical colors. Unlike chemical colors, which result from molecular bonds, structural colors arise from the architectural structure of molecules that filter light in specific ways (Assis, 2013). This phenomenon is observed in nature, such as in the blue wings of butterflies. The discovery that some colors derive from the physical structure of materials at the microscopic level inspired the development of optical nanotechnology (Paleja, 2023).

While Vantablack is not the only structural color produced through nanotechnology, it was one of the earliest. NanoLab introduced AdVANTA in 2017 (Optical Black Coatings, 2023), and MIT developed Ultrablack CNT in 2019 (Chu, 2019). In 2021, Purdue University created a superwhite color, which, while not made with nanotechnology, is often compared to Vantablack (Wiles, 2021). In 2022, Singaporean researchers developed a red pigment using nanotechnology (Site Inovação Tecnológica, 2022).

The controversy sparked in the art and color industries by Vantablack opened new avenues for exploration. Before its collaboration with Anish Kapoor, Surrey NanoSystems had not anticipated Vantablack's application in these domains. The controversies surrounding it established Vantablack as a potential new method for producing structural colors for art purposes using nanotechnology, encouraging competition and the entrance of other companies and products into this emerging field.

Following Vantablack, developments in superblack materials initially intended for telescopes and military applications, such as AdVANTA and Ultrablack CNT, were soon joined by products designed for the art world. NanoLab, for instance, created a black oil paint called Gravity Black Oil Paint, as well as a soluble paint using nanotubes called Singularity Black. It also made a partnership with artist Jason Chase to demonstrate its artistic potential (Optical Black Coatings, 2023). MIT also promoted the artistic application of its superblack by collaborating with artist Diemut Strebe, who used the nanotechnology coating in his artwork 'Redemption of Vanity' (Chu, 2019).

As explained above, the development of Vantablack and similar ultra-black materials originally served only technical applications. For the scientists and engineers behind these innovations, artistic use constituted an afterthought at best, an accidental byproduct of research targeting functional rather than aesthetic purposes.

This stands in stark contrast to the artistic perspective that fueled Stuart Semple's opposition and the subsequent creation of alternative pigments. Where scientists see

precise light absorption measurements, artists recognize a medium for human expression. Where technologists develop materials to solve engineering problems, creative practices engage with color as cultural communication.

The ongoing controversy ultimately reveals two irreconcilable frameworks: one that evaluates Vantablack through metrics of technical performance, and another that interrogates its cultural meaning and accessibility. This fundamental tension—between color as quantifiable phenomenon and color as lived experience—persists throughout every stage of the debate.

Innovationism, characterized by the pursuit of novelty as the primary focus of research and technological development, is embedded in a deterministic view of technology as a linear and cumulative process that prioritizes efficiency and short-term profit. In the case of nanotechnology, the uncertainty surrounding its present-day viability underscores the need to connect with mass audiences through demonstrations and aesthetic experiences, grounded in promises of future potential. The seemingly contradictory partnerships formed by Surrey NanoSystems, which blend an aura of sophisticated technology with purely commercial actors across both high- and low-end markets, can be understood within the framework of innovationist processes. Novelty itself serves as a justification for its development in a type of framing that is not familiar to an artistic and sensible perspective of color.

4. ANISH KAPOOR AND INNOVATIONISM IN THE ART WORLD

In the previous section, we explored how Surrey NanoSystem's public demonstrations of Vantablack align with narratives of nanotechnology and innovationism. In this section, we will examine the nature of these demonstrations, identifying the aesthetic values and mechanisms at play to better understand their presentation. Several common characteristics are evident across Vantablack's exhibitions. First, these displays are never permanent; they are transient, typically lasting only a few days or, at most, a few months. Opportunities to see Vantablack are rare and limited. For instance, after its appearance on The One Show in 2016, it was publicly displayed for approximately one month, and less so by Lynx deodorant. In 2019, Vantablack was featured only at the Frankfurt Auto Show and as part of Gesaffelstein's stage design at the Coachella Festival, both short-lived events. In 2022, it was displayed in Kapoor's works at the Venice Biennale, with some of his pieces continuing to circulate in temporary exhibitions worldwide.

A significant aspect of these presentations is the cultivation of an image of exclusivity and luxury. These events are often not fully open to the public. In the more accessible displays, such as those organized by Lynx and BBC, attendance requires registration, and spots are limited. The other venues, such as art galleries or car shows, are restricted spaces that either require paid entry or special invitations. Apart from public exhibitions, the other means of experiencing Vantablack is through the purchase of products incorporating the material, most notably luxury watches, which can cost nearly $100,000 (Fenner, 2016).

Surrey NanoSystems effectively associates Vantablack with values of rarity, exclusivity, luxury, and sophistication. When viewed alongside the marketing strategies, media reports, and social media activity surrounding the material, the importance of spectacle becomes clear. Vantablack, often referred to as the "blackest material in the universe" and compared to a black hole, is portrayed as capable of transforming not only science and technology but also our perception of reality. These narratives are crafted to inspire awe and admiration.

In the realm of art, Vantablack's allure can be attributed to its unique optical property: complete opaque blackness. From the perspective of optical physics, color is an electromagnetic wave with a specific wavelength perceived by humans, and its properties can be quantitatively measured. In this context, black is the absence of light, occurring when no such waves are present. Black is thus associated with darkness[3]. This perspective is useful when discussing light as color. However, color is also experienced in a different dimension. Light rays interact with objects, which absorb and reflect certain wavelengths, depending on their properties. This interaction is the basis of color-pigments, defined by the chromatic elements present in molecules[4] (Pedrosa, 2009). In this context, a black object absorbs all incident light, yet in reality, even black objects reflect some light, allowing us to perceive their three-dimensional form.

Thus, color-light and color-pigment are two distinct dimensions of color perception, operating according to different principles. In color-light, the primary colors are red, green, and blue, and combining green and red light results in yellow. Conversely, in color-pigment, the primary colors are cyan, magenta, and yellow, and combining red and green pigments results in a neutral gray. Each dimension operates under different color

[3] This understanding of color originates from Isaac Newton's prism experiments, which demonstrated that visible colors (the rainbow of the color spectrum) are components derived from white light.

[4] This dimension of color (as material pigment mixtures) is the one most commonly employed by artists in their practical work with paints and pigments.

systems, requiring distinct color wheels (Silveira, 2015). Vantablack bridges these two realms, producing a black pigment in physical objects that mimics the blackness of color-light. Its exceptionally low reflection rate makes the black pigment appear as it does in the absence of light. This is why Vantablack can be considered a new color, and why its experience is so captivating, as it challenges our usual perception of objects.

However, other manipulations of pigments have previously achieved similarly opaque black effects in physical materials. Many artists have already explored these effects in their works, with Anish Kapoor being one of the most notable. In fact, Kapoor's extensive history with the use of black pigments legitimized his exclusive control of Vantablack. His use of black is rooted in a quest to translate darkness into physical form, resonating with internal emotional states. Kapoor himself has stated, "A work will only have that deep resonance that I try to indicate if the kind of darkness that I can generate, let's say in a block of stone with a cavity in it that's very dark, if the resonance that's in that stone is something that is resident in you already." (Vidal, 2014, p. 54).

Our aim here is not to conduct a poetic analysis of Kapoor's works but to highlight that he had already succeeded in achieving total blackness before using Vantablack. For example, Adam (1989) features a block of stone carved and painted with dark blue pigment, creating a squared form that contrasts with the organic nature of the limestone. In Descent into Limbo (1992), a black hole in the ground confuses the viewer's sense of two- and three-dimensional space, to the extent that in 2018, a visitor to the installation fell into the hole, resulting in hospitalization (Block, 2018). By contrast, works made with Vantablack, like Non-object Black (2022), must be enclosed in glass boxes due to the material's fragility and toxicity. The reflective glass, however, diminishes the sense of infinite depth that Vantablack is meant to evoke, having less impact than Kapoor's previous works.

If Kapoor had already mastered the use of black to evoke darkness, why adopt Vantablack? Despite its remarkable properties, Vantablack is costly and difficult to produce. Moreover, after the negative backlash surrounding Kapoor's exclusive rights to the material, there was heightened anticipation and scrutiny surrounding his work with the nanotechnology. To understand this, we must consider how contemporary art engages with technology.

According to Paulo Laurentiz (1991), in the shift from modernism to postmodernism, materials are no longer viewed as passive and malleable in art-making. Instead, their resistance is acknowledged as an agency in itself. In contemporary art, the interaction between materials and the artist's subjectivity co-produces the artwork. Thus, materiality

—rather than the material itself—becomes the focus. As Gompertz (2013) observes, post-modern art fundamentally engages with critical questions of authenticity, authorship, reproduction, and identity. Contemporary artistic practice particularly emphasizes experiential and entertainment values, while reconceptualizing materials as active agents capable of their own expressive potential (Gompertz, 2020).

Therefore, for Kapoor in particular, it is not just the optical effect of Vantablack that matters, but the process by which it is made, including its technical and material challenges. Poetic narratives actively incorporate and explore all elements inherent to the materiality we have previously discussed. Vantablack's rarity, its high cost, it all creates poetic meaning, that changes the way spectators relate to the artwork, as well as the interaction between artist and material. The difficulty of production, the rarity and the high cost are not obstacles but integral to his artistic choice. Kapoor uses Vantablack because it is expensive, exclusive, and innovative.

This approach is consistent with Kapoor's career and artistic philosophy. Many of his works employ advanced technology and command high prices. In his pursuit of illusionism, Kapoor manipulates monetary value as a mythological element, attributing emotional significance to the symbolic power of high prices. His artistic endeavors frequently require substantial financial backing to achieve the desired results (Vidal, 2014). Kapoor's exclusivity in using Vantablack can be seen as part of his broader artistic practice —an artistic performance in its own right. At this point, technology, market forces, and poetics converge, with the latter becoming intertwined with issues of private property, commerce, and the creation of myths.

Innovation is a central theme in contemporary art, often linked to the intersection of art, market and technology. While art movements like Dada and Pop Art have questioned notions of originality and individuality in art creation, art historian Will Gompertz (2013) notes that in the more established realms of the art world, values of originality, authenticity, and rarity remain fundamental. These values are crucial for the art market and influence the pricing of artworks.

We cannot incur in an apocalyptical view of technology. Evidently, not all forms of novelty constitute the "innovationism" we critique here. As Winner (2013, p. 65) observes, some innovations are benign—those whose creative processes respect traditions while opening new, fruitful possibilities. What defines the innovationism we critique is its ideology of abrupt rupture with the past and its primary focus on market-driven profit through privatized processes.

Therefore, in analyzing Kapoor's engagement with Vantablack, we must recognize that the mere presence of material agency—that understanding of artistic media as co-creators central to much poetic practice—does not itself constitute innovationism. The decisive factor lies rather in the particular terms of this relationship. Kapoor's valuation of Vantablack foregrounds its most ideologically charged aspects: its presentation as a self-evident technological breakthrough that demands acceptance (a stance echoing technological determinism's fiction of context-free invention), coupled with its feature of an exclusive commodity (embodying neoliberal strategies of value extraction through artificial scarcity and market capture).

The connection between Kapoor's framing and these problematic innovation paradigms emerges not from any general poetic impulse, but from the specific values these representations carry—namely, the naturalization of innovation as private property and technological change as an autonomous force.

5. STUART SEMPLE AND THE RACE TO A NEW SUPERBLACK

The role of invention as a driving force in the development of science, technology, and art is particularly evident in exclusive spaces like nanotechnology laboratories and the Venice Biennale, as previously discussed. It is precisely against these spaces and their exclusivity that Stuart Semple frames his actions. Both his products and declarations challenges the values of exclusivity, rarity, luxury, and sophistication associated with Vantablack, as established by Surrey NanoSystems and Anish Kapoor, and rooted in an innovationist framework.

We emphasize Semple's response not merely for the critical stance he claims to uphold, but fundamentally for its mode of intervention. Rather than limiting himself to discursive critique or symbolic protest, his opposition operates within the productive sphere—becoming the first to develop an alternative material to rival Anish Kapoor and Surrey NanoSystems.

Denied the opportunity to act as a consumer, Semple adopts the role of a manufacturer. Since Vantablack is not available for purchase, Semple creates his own "superblack" that is accessible to the public. However, there is an inherent asymmetry between Semple's enterprise and that of Surrey NanoSystems. While Semple's company, Culture Hustle, specializes in producing paints and pigments for artistic purposes, Vantablack's application in art is the result of a negotiated arrangement with Kapoor—it was not originally

intended for such use. Vantablack is produced using complex and costly nanotechnology processes, whereas Semple employs acrylics and pigments in a nearly artisanal manner. In this way, by positioning his product as a counterpart to Vantablack, Semple is also questioning its fundamental nature, challenging Surrey NanoSystems' assertion that Vantablack is not a color, but a material.

According to Semple (2021), inks, paints, and pigments can be categorized along two axes: ordinary/extraordinary and accessible/inaccessible. Ordinary, affordable paints are those commonly used by artists in their daily work, widely available in art supply stores, and often of lower quality. In contrast, products like Vantablack are extraordinary, both difficult to produce and rare. They possess unique optical effects and are inaccessible to the general public. Therefore, according to Semple's narrative, Culture Hustle's goal is to make extraordinary materials affordable and available to all.

His framing represents a stark contrast to the framing of Surrey NanoSystems and Kapoor. Culture Hustle is positioned as providing materials that are not expensive, toxic, or exclusive. Semple's discourse centers on "sharing the world's flattest, mattest, blackest art material," and offering a "better black," one that is superior not because it is less reflective, but because it is accessible (Semple, 2017). Semple's activism in other color disputes—against Tiffany's and Barbie's color trademarks or Pantone's paid digital color packages—further reinforces this democratic approach. As a result, he has been labeled the "Robin Hood of the art world" by some journalists (Leffler and Shannon, 2023).

This type of qualification is symptomatic of a significant contradiction in Semple's practice and narrative. The artists' own statements often contain self-promotional distortions, particularly in the competitive art market, and no matter how democratic or critical Semple's interventions may appear, they are not free from contradictions. While Kapoor is already one of the most prominent figures in the international art scene, Semple was virtually unknown until the Vantablack controversy. His activism enabled him to build an international career. This contradiction is consistently evident in his behavior: on one hand, a democratic hero; on the other, an opportunist who leverages political debate to profit from his paint company and gain visibility in the art world.

Despite their disagreement, Semple's enterprise shares common ground with the very actors he opposes. To compete or create a narrative of competition, he must engage in the same market space. Ultimately, Semple also seeks to produce a superblack, which explains his initial sense of exclusion from Kapoor's monopoly over Vantablack. He too is captivated by the allure of total opacity, and though he does not frame it as exclusive, he emphasizes its fascination.

On the other hand, Semple's framing of colors encompasses not only their intrinsic optical properties but also the ideological, economic, and cultural values associated with art and technology. In the case of Culture Hustle, extraordinary colors are not only those that behave uniquely—shining, changing, highly saturated, or opaque—but also those that are somehow forbidden. At times, the extraordinary resides more in the narrative surrounding the color than in the color itself. Semple frames his products as art performances, integrating poetic, technological, and political dimensions into a unified whole. In aesthetic terms, Semple does not reject the fetishistic or sublime experiences associated with superblacks, nor their role in spectacle—all of which are central to Kapoor's use of Vantablack.

It is also important to recognize that while Semple contests the meanings surrounding Vantablack, highlighting its exclusive associations and offering an alternative, Vantablack profoundly influences him. His artistic practice increasingly engages with issues surrounding color controversies, making them central to his career.

His discourse, however, can sometimes be violent. In a behavior typical of social media dynamics, he tends to amplify his voice by diminishing the opponent, often creating caricatures that simplify and exaggerate their positions. As art historian John Gage cautions, artists' public statements should not be taken at face value, as they are often mediated by self-promotion (Gage, 1999). In Semple's case, some of his rhetoric can border on incitement, including personal attacks on Kapoor, whom he has compared to murderers and labeled a "smelly rotter" (Semple, 2015).

Moreover, while Semple promotes accessibility, the prices of his products are not necessarily inclusive, especially outside the UK. Additionally, there are significant differences in how he and Surrey NanoSystems protect their innovations. Legal mechanisms, such as patents, are designed to strike a balance between rewarding inventors and preventing monopolies (Morales *et al.*, 2022). Patents offer protection while also making the invention's details public. In contrast, Semple's superblacks are protected through trade secrets, which keep their production methods hidden from the public. From this perspective, Vantablack's patent system is arguably more transparent than Semple's informal protection methods.

Beyond the legal and policy issues, the ethical and political debate surrounding access and common use remains crucial. Despite Semple's contradictions, his activism has succeeded in disrupting what was previously a monopoly. It is a fact that before his intervention Vantablack was the only superblack available and was exclusively reserved for

Kapoor. Semple not only created an alternative superblack but also inspired other companies to develop their own versions, many of which are now used in artistic representations.

At the same time, Semple's actions align with the innovationist paradigm at some degree, as he competes to develop the blackest black and other novel pigments—framed as groundbreaking advancements in color production—while reinforcing an economic enterprise that bolsters his own career. However, his framing diverges from the neoliberal market, which prioritizes profit as the main objective of invention. Semple emphasizes political concerns of access as the central focus. While we might question whether his political narrative serves more as a marketing strategy to promote his products and enhance his personal brand, these shifts remain important in challenging the innovationist model.

6. FINAL REMARKS

In this study, we examine the role of innovationism in the sociotechnical controversy surrounding Vantablack—a dispute that intersects science, technology, color, art, politics, law, and economics. We begin by outlining the key events, identifying the primary actors and their interactions. After presenting the main theoretical frameworks, we analyze how innovationism influences the actions and narratives of those involved in the controversy.

Our findings reveal that the actions of the actors involved in the controversy continually frame, disrupt and contest the materialities, meanings, and applications of Vantablack—all in constant interplay with innovationism. This innovationist drive is, at certain points, shared among the actors, while at others, it is contested; yet it remains an ever-present force in their practices. We demonstrate how the notion of groundbreaking inventions, driven by corporate profit motives, permeates the contemporary art world, intersecting with both aesthetic and ethical values. Simultaneously, we observe that even within these contradictions, there are ongoing disputes over which ethical principles should guide innovation—whether market-oriented scopes or democratic values rooted in accessibility.

Further, our research identifies key connections between innovation, technological determinism, and neoliberalism, which manifest in the contradictory stances of all primary actors. Surrey NanoSystems, for instance, promotes Vantablack as a sophisticated technology while forming partnerships with low-end commercial sectors, resulting in discursive incoherence. Kapoor, despite his pursuit of technological novelty, had already achieved similar aesthetic effects prior to Vantablack, exposing the complexities of

artistic processes and their entanglement with market dynamics. Semple, though framing his practice as democratic, engages in controversial and Manichean rhetoric for self-promotion. Beyond these individual contradictions, we also highlight the irreconcilable perspectives on color—whether as a byproduct of nanotechnology or as a medium for artistic expression.

Despite the centrality of innovationism in these debates, we argue that while it exerts a strong influence, extending into the artistic sphere, it is still possible to challenge this paradigm through actions that integrate artistic, technological, scientific, and industrial dimensions within a single agency. Although Stuart Semple's many contradictions, his emphasis on accessibility as the ultimate objective of technical and artistic production points at a good direction, because it makes us think of ethical implications of technical choices. Based on this type of concern, we can imagine an alternative approach for considering the kinds of innovation public policy might support and invest in.

The neoliberal claim that the profitability of innovation leads to social development rests on the assumption that technology is neutral and exists outside of politics and ethics. Its autonomous growth is presumed to result in greater efficiency and, consequently, enhanced productive capacity. This notion believes that market economies are inherently rational and that their autonomy ensures sustainable development when left unregulated (Harvey, 2004). Innovationist policies are grounded in these concepts. As we find in this research, such concepts are also present in art, culture and technology.

A way to challenge this doctrine is to develop innovation with alternative foundations and outcomes in mind. The key to opposing the idea that both technology and the economy are neutral, apolitical entities lies in incorporating ethical and political values into the innovation process, thereby redefining its primary objectives beyond mere technical efficiency. Maybe this controversy can help us question why do we need superblack colors and how we want them to be made, shared and used.

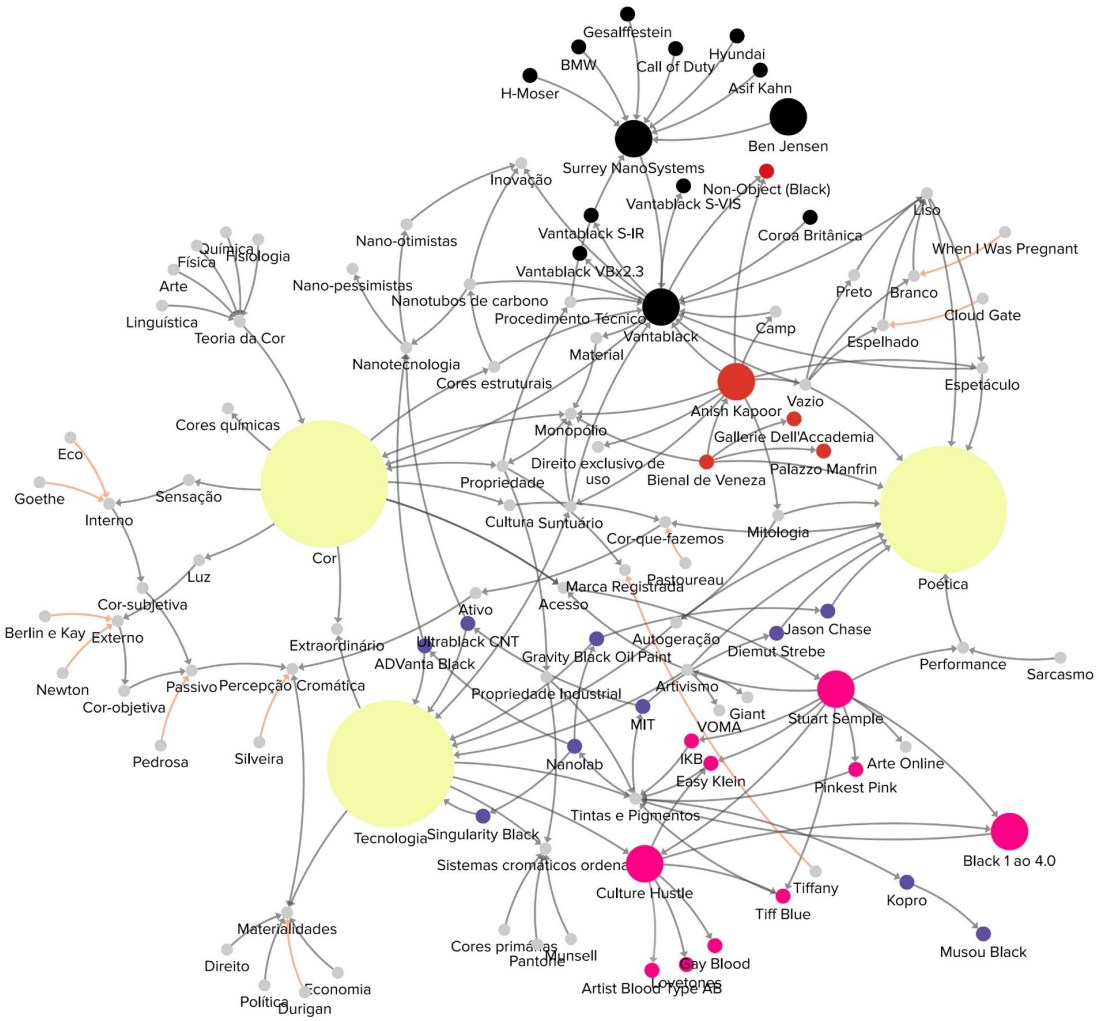

Figure 1. Sociotechnical map of the Vantablack controversy: actors, products and relations.
Source: elaborated by the author.

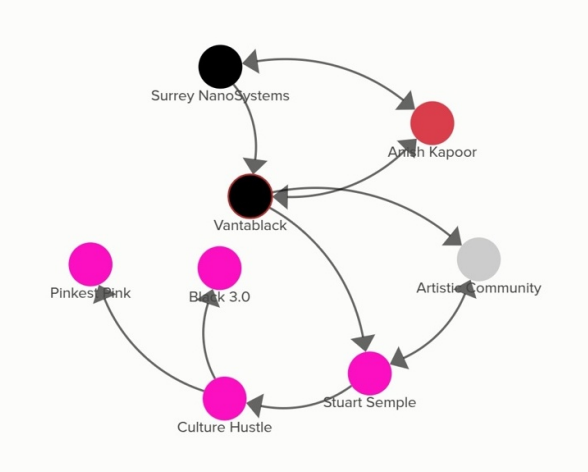

Figure 2. Network of Key Actors in the Vantablack Controversy.
Source: elaborated by the author.

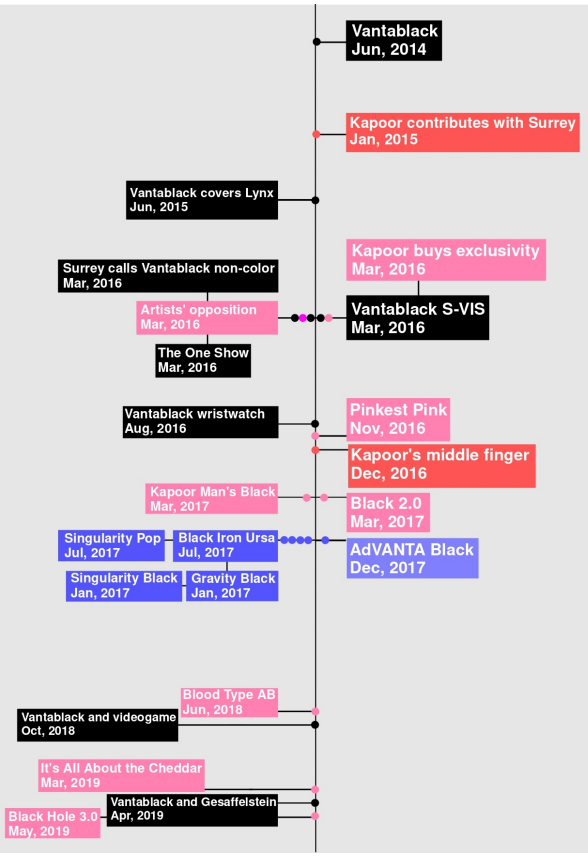

Figure 3. Timeline of the Vantablack Controversy and Related Developments.
Source: elaborated by the author.

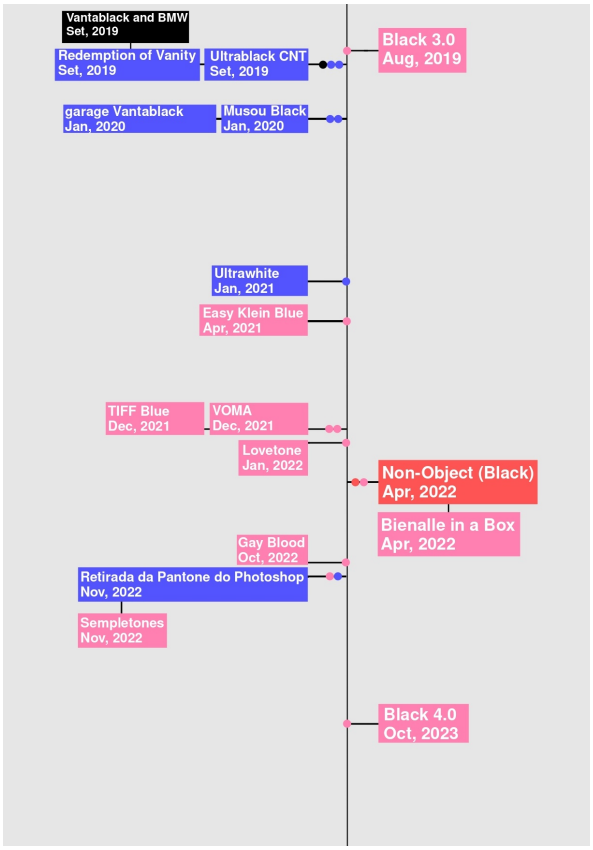

Figure 4. Timeline of the Vantablack Controversy and the Ultra-Black Color Race (2019–2023).
Source: elaborated by the author.

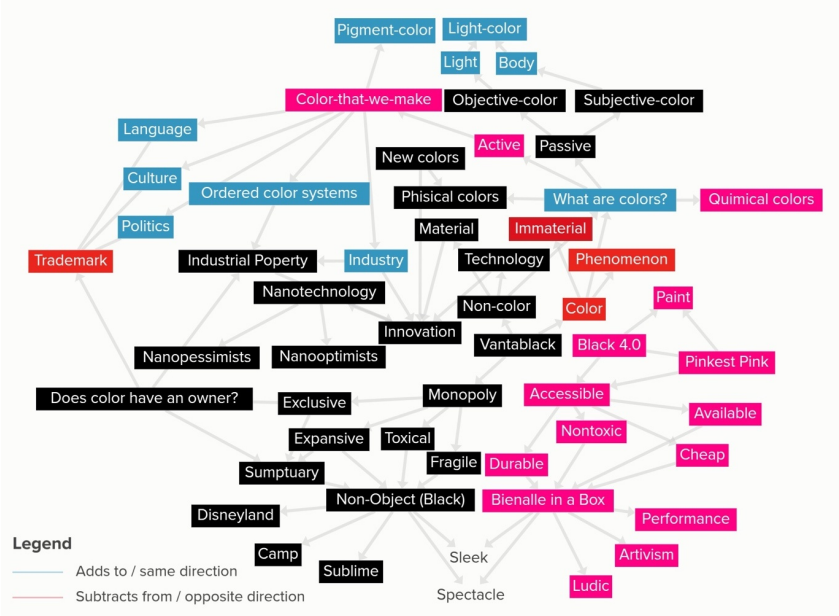

Figure 5. Mind Map of Color: Perception, Innovation, and Ownership.
Source: elaborated by the author.

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Curation, Compliance, Consolidation

Understanding the Limits of Innovation Policy's Turn to Creativity

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ABSTRACT

In recent years, innovation policy has increasingly turned to creativity as a resource for economic revitalization, social cohesion and sustainability transitions. In urban redevelopment, creative districts blend innovation logics of a "creative class" and "transformative innovation" with experimental urban governance to address grand challenges and enable broader societal transformation. Building on critiques of the idea that innovation and creativity function as "magic bullets" in the contemporary economy (Pratt & Jeffcutt, 2009), we explore the limits of this transformative promise in this article. Our analysis is grounded in ethnographic fieldwork across four creative district projects in Munich, Germany, where normative visions of creativity and innovation are rendered legitimate and governable. Through the conceptual lens of regional innovation cultures (Pfotenhauer *et al.*, 2023), we examine how the creativity-innovation-nexus is locally stabilized and tamed through distinct cultivation mechanisms, summarized as *curation*, *compliance*, and *consolidation*, that reinscribe existing socio-political settlements and market-driven valuation logics of the common good. Paradoxically, Munich's creative districts foster a form of *conservative creative innovation* that constrains the transformative potential of creative innovation by reproducing hegemonic power structures and marginalizing alternative visions of conviviality (Robra *et al.*, 2023). We argue that creative districts—and similar initiatives—risk undermining their potential as open, experimental spaces for radical transformation when they prioritize innovation's productive role over creativity's more politically contested and disruptive capacities

Keywords: Innovation Policy; Creativity; Creative District; Regional Innovation Cultures; Control; Power.

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INTRODUCTION

> "Future economic growth will be driven by creativity and innovation; so if we want to increase it, we have to tap into the creativity and innovative spirit of everyone."—(early) Florida in an interview (Tucknott, 2009)

> "This wonderful area [Munich's Kreativquartier] could be the… steppingstone of the future. It could be a gravitational field for the whole city. One would really have to mess up a lot of things if you cannot get this right."—Andreas Krüger, renowned urban planner for creative districts (Niesmann, 2018)

In recent years, scholarly and public debates about innovation policy have come to embrace "creativity" as key concern, both as an instrumental resource that should motivate cities to create spaces for a flourishing creative class (Florida 2004, 2014), and as a mode of critical engagement towards forms of "convivial innovation" (Robra *et al.*, 2023) in line with the need for social, economic, and ecological transformation in a post-growth era. According to president of the European Commission Ursula von der Leyen, creativity is essential to addressing grand societal challenges and ever-rising competitiveness concerns. This has prompted supra-national developments such as the EIT Culture and Creativity (EIT, 2024) or the New European Bauhaus initiative (European Urban Initiative, 2022) as essential part of the European Green New Deal to marshal "an explosion of creativity" (EU, 2024) across the Union. With mottos such as "beautiful—sustainable together"—, these creative culture projects are imagined as sound economic investments while also making the future more democratic, inclusive, and sustainable through trans-disciplinary bridges between science and technology, art and culture (EC, 2019; EU, 2024a). Recognizing the essential role of cities in contributing to said transformations, the push for creative innovation increasingly translates into the promotion of creative districts as an urban development strategy. While they have been popular since the early 2000s as instruments for economic development (Florida 2004, 2014), the latest renditions push the narrative of a mode of creative innovation that brings about superior solutions in conjunction with worthwhile urban futures by combining technological innovation, start-up scenes, and community-based art and (sub)culture approaches. In the pursue of desirable visions for urban housing, mobility, energy efficiency, and social equality (EP & EC, 2009), creative districts thus aim to serve as experimentation sites that seemingly embrace both affirmative and subversive nuances of creativity and respective solutions, which leads to a range of tensions.

Critically asking how transformative the creative turn in urban innovation policy can really be, this article explores the current entanglements of innovation logics in creative district projects. Approaching creative innovation as a form of x-innovation (Gaglio *et al.*, 2019), we begin by putting it in conversation with existing critiques of innovation policies and tendencies of "capitalist culturalization" (Suitner, 2015). Subsequently, we lay out how the creative district approach does not happen in a vacuum but is embedded in locally engrained cultures of urban governance and innovation, including histories of potentially subversive (counter)culture and existing urban gentrification challenges. Against this background, we investigate the locally stabilized understanding of creative innovation in four seemingly transformative creative district projects in the city of Munich, Germany: the *Munich Kreativquartier* (KQ), the *Werksviertel-Mitte* (WM), the *Sugar Mountain* (SuMo), and the *Bahnwärter Thiel* (BT). Through the conceptual lens of regional innovation cultures (Pfotenhauer *et al.*, 2023)—which foregrounds how innovation becomes aligned with local identities, economic legacies, and political cultures—we interrogate the transformative power of the creative turn in urban innovation policy. Specifically, we question which underlying ideals of social order are perpetuated within these initiatives, and who gets to express and participate in these respective visions. We find that Munich's approach to cultivating creative innovation can be captured through three empirically grounded mechanisms—*curation*, *compliance*, and *consolidation*—which emerged inductively from our fieldwork. Together, they produce a primarily market-based, high-tech-driven urban transformation pathway shaped by established public and private actors, while alternative visions based on social reform or counterculture resistance are systemically sidelined. These findings are consistent with existing research showing that Munich embraces a conservative innovation culture that aims to preserve, rather than disrupt, socio-economic settlements and technological trajectories. All four creative district projects thus fail to serve as experimental space for diverse, commons-based negotiations about the direction of urban transformations, and instead reproduce Munich's socio-economic order. We argue that the observed conservative mode of creative innovation does not just reinforce existing forms of marginalization, excluding non-male, non-white, non-capitalist, and non-academic perspectives from participating in urban future-making. Innovation policy, moreover, foregoes some of the most crucial aspects of how creativity relates to urban transformation, and in doing so, Munich's creative districts paradoxically limit and undermine the transformative potential of creative innovation.

1. THEORIZING CREATIVITY IN INNOVATION

1.1. STATE OF THE ART: CREATIVITY BEYOND MAGIC BULLETS?

Building on existing critiques of late industrial modernity, and technology optimism, recent STS scholarship has increasingly scrutinized how innovation has become a powerful logic and the proclaimed panacea to a multitude of social, ecological and economic challenges, pushing cities and regions to adapt innovation-centric development strategies likewise (Gaglio *et al.*, 2019; Irwin, 2023; Pfotenhauer & Jasanoff, 2017; Wisnioski, 2025). Among other things, both scholars and policy-makers have acknowledged that abstract, standardized innovation frameworks—such as the "linear model" or the "triple helix" of innovation—are inapplicable or even harmful when imported into a specific local context without adapting to the profoundly different institutional, political, and sociocultural contexts (Arocena & Sutz, 2000; Cassiolato & Vitorino, 2011; Delvenne & Thoreau, 2017; Godin, 2017; Irwin *et al.*, 2021; Kuhlmann & Ordonez-Matamoros, 2017; Macq, 2020), and that framing contemporary policy problems as mere deficits of technological innovation "tends to marginalize other rationales, values, and social functions" (Pfotenhauer *et al.*, 2019, p. 894; Cuevas-Garcia *et al.*, 2024; Vinsel and Russell, 2020). Consequently, calls for counterhegemonic narratives that succeed to address social inclusion and post-growth perspectives led to a multitude of seemingly more systemic innovation approaches with buzzwords such as *social*, *open*, *public*, *reflexive* or *convivial innovation* (Brandão, 2023; Chesbrough *et al.*, 2008; Godin *et al.*, 2021; Godin & Vinck, 2017; Hutter *et al.*, 2018; Pfotenhauer & Juhl, 2017; Rammert, 2010; Robra *et al.*, 2023).

According to Thrift (2022), the explosion of creativity as a value in itself is inherently tied to the increasing pressure to innovate, as underlined by popular a management-adviser's claim that "giants [must] learn to dance" (Kanter, 1990), the notion of the *Homo Silicon Valleycus* as a particularly creative type and the proclamation of the creative age (Seltzer & Bentley, 1999; Thrift, 2000). In urban development, contributions on "creative cities" (Landry, 2008; Reckwitz, 2012; Scott, 2006) and "creative industries" (Hartley, 2005) highlight how the driving forces increasingly jumped on the creative bandwagon with Richard Florida (2004, 2014) famously envisioning the "creative class" to help spur high-tech growth in urban hotspots with creativity having replaced natural resources as key factor in our economy and society:

> "To be successful in this emerging creative age, regions must develop, attract and retain talented and creative people who generate innovations, develop technology-intensive industries and power economic growth." (Gertler *et al.*, 2002, p. ii)

The discipline of urban studies accordingly describes a shift from creativity as a local asset to beautify the city and attract more people to an increasing economic hyper-focus on technological innovation, entrepreneurship, and startup urbanism (Chapain & Sagot-Duvauroux, 2020)—a development which is most famously mirrored by Margaret Thatcher's neoliberal enterprise culture regime in the UK (Peters, 2001). This progression of "creative capitalism" (Kinsley, 2009) or "capitalist culturalization" (Suitner, 2015) was met with criticism from various academic fields, dismissing the idea of the creative class as the next magic bullet in urban development (Pratt & Jeffcutt, 2009) as a romanticized and mythical doctrine which is over-emphasizing conservative norms such as performativity and productiveness (Osborne, 2003; Williams *et al.*, 2013) while failing to account for social needs and local idiosyncrasies (Tremblay & Pilati, 2013). Nevertheless, creative innovation remains a staple in urban development, whereby scholars have underlined the value of creative cultures beyond its economization, showing how we have moved from one-sided bashing of either economists or creative cultures to a genuine interest in understanding each other (Hutter & Throsby, 2011).

Here, we encounter an ongoing interest of politicians and policymakers in creative districts[1] as an urban development tool that pushes for life-long learning and the exchange of ideas between actors from diverse backgrounds, synergistically combining technological and social innovation to imagine a worthwhile urban future with sustainable economic development as well as greater social cohesion (EC, 2006; Merkel, 2009; Mølholm, 2014; Moulaert *et al.*, 2007; Sacco *et al.*, 2014). Scholars specifically highlight the embrace of art, protest, and subculture scenes as a way to break out self-replicating patterns (Montuori & Donnelly, 2023), and to rethink existing practices (Berthoin Antal & Strauß, 2013) in a pursuit of socially equitable and locally rooted solutions to urban innovation (Tremblay & Pilati, 2013). This ties to a larger body of research on the co-evolution of art and science (Hutter & Throsby, 2011; Rogers, 2022) with counterculture bringing an unconventional "sense of dissonance" (Stark, 2009) that has historically been vital for scientific break-throughs (Kaiser, 2012). With regard to urban innovation, Thornton (1995) has coined the notion of the rebellious yet economically viable "subculturepreneur", and EU research frameworks have recognized the power of artistic intervention to promote socially desirable innovation opportunities (Rogers, 2022). While many authors have embraced Deleuze's claim that authentic creativity is as destructive as it is productive (Deleuze, 1992; Osborne,

[1] For the purpose of this paper, we refrain from defining either the increasingly fuzzy creative district approach (Chapain & Sagot-Duvauroux, 2020) or creative innovation as such. Instead, we approach these as actor's categories with an interest in their locally negotiated understanding.

2003), the Schumpeterian (2008) framing of creative counterculture as an ingredient of superior innovation remains predominant. This begs the question whether creative innovation and the approach of creative districts can deliver on its vision of more holistic approaches for urban future-making. Against the background of STS's calls for alternative approaches to the pro-innovation bias (Godin & Vinck, 2017), this research paper thus aims to investigate how creative innovation plays out in creative district projects, specifically including the local context of Munich to avoid a detachment from the idiosyncratic sociopolitical order and state logic, as criticized in Florida's (2014) early conceptualization of the "creative class".

1.2. EXPLORING CREATIVE INNOVATION IN MUNICH'S CREATIVE DISTRICTS

This paper builds on the aforementioned bodies of work and puts them in conversation with the conceptual lens of regional innovation cultures (Pfotenhauer *et al.*, 2023), referring to:

> "[The] unique ways in which regional innovation initiatives and technology developments (their goals, meanings, material organization, and actor constellations) are being brought into alignment with local identity, socio-economic legacies, and unique political cultures." (p. 2)

As self-proclaimed transformative hubs for strengthening the creativity-innovation-nexus, creative districts serve as an empirical focus for investigating how innovation logics are culturally, politically, and materially anchored as part of these alignment processes. Instead of neutral containers, they act as spatial policy tools where situated normative visions of innovation and creativity are rendered legitimate and governable—as Thrift (2022) puts it: "To govern, it is necessary to render visible the space over which government is to be exercised" (p. 677).

Through this lens of innovation cultures, the specific semantic extension of "innovation" to accommodate "creativity" (and vice versa) in the name of "transformation" becomes visible and reveals, as we will argue, patterns of restriction and control. What is more, our approach suggests that much can be gained from looking comparatively at different sites of implementing "creative districts" as an increasingly standardized innovation model in its own right, which is, however, beyond the scope of this paper.

Embedded within Munich's specific sociocultural and—political order (see section 3.2), we read the locally established and accepted modes of creative innovation as interrelated with (un)desirable forms of creative cultures in the investigated urban development projects. To explore the transformative potential of creative innovation as featured in Munich's creative district projects, we zoom in on three analytical questions: (1) Which ideals of social order are perpetuated by said creative innovation? (2) Who gets to articu-

late their visions of creative innovation in the urban district projects? (3) How is this form of creative innovation cultivated? Inspired by Brandão and Bagattolli's (2023) invitation to approach ciritical innovation studies as vital resource for STS scholars, this paper specifically focuses on (3) as we want to understand how and why the respective form of creative innovation is cultivated within the creative districts instead of merely criticizing it. Based on our empirical work, we find powerful mechanisms of cultivation are indeed at work in our cases. The three described modes of cultivation—*curation*, *compliance*, *consolidation*—are the result of our inductive research and serve as useful synthesizing heuristic to understand how the role of creativity is understood and enacted in Munich's innovation culture.

2. APPROACH AND EMPIRICAL INSIGHTS

2.1. METHODS

Methodologically, we performed short-term focused ethnographies (Knoblauch, 2005) in four self-proclaimed creative district case studies (Yin, 2009) in the city of Munich, Germany, between autumn 2022 and summer 2024. Throughout that period, we conducted 35 semi-structured interviews with involved actors from on-site creative cultures including artists and NGOs as well as high-tech start-ups and enterprises, the city administration and council politicians, planning and property administration agencies as well as public and private investors. This main body of research was complemented by an extensive document and website analysis of respective project plans and narratives, a close study of media articles featuring the surrounding discourses and developments, ethnographic observations during four public on-site events as well as ethnographic sketches to make visible our observations and reflect on our own process of knowledge making (Kuschnir, 2016; Taussig, 2011). The collected data was transcribed and coded to work out competing visions of creative innovation, how particular actors are positioned to shape them, and how the hegemony of certain visions over others was stabilized through the creative district initiatives. The thematic analysis (Bryman, 2012; Charmaz, 2006) draws on previous research results from the *Regional Innovation Cultures* group at TU Munich as well as on the city's histories of creative (counter)cultures, which we summarize in the next section.

2.2. EMPIRICAL SETTING

With its current Global Innovation Index ranking as best innovation cluster of Germany (Munich RAW, 2023), Munich, the Bavarian state capital, has successfully cultivated an image as global innovation powerhouse. The aspiration to be recognized as a high-tech region precedes the current innovation era and dates back to what Grüner (2009) has called a "planned economic miracle" of post-WWII Bavaria. This transformation "from agrarian country to high-tech state" (Stoiber, 1994) was buoyed by clever lobbyism, high-tech economic investment programs (Berger, 2002), the strategic attraction of key industries, and the systemic build-up of an innovation ecosystem. Today, Munich is home to major international companies from the established and growing business sectors of automobility, microelectronics, aerospace, and biotechnology, supplemented by major public research and innovation investments in future technologies such as quantum and AI. At the same time, Bavaria cultivates a self-conscious image as Germany's most conservative state. With Munich serving as the seat of the federal provincial government, the conservative Christian Social Union (CSU) occupies a dominant role in putting forward a form of innovation that goes hand in hand with cultural traditionalism and agricultural romanticism, as underlined by promotional slogans such as "with laptop and lederhosen" and "with bits and pretzels". Pfotenhauer *et al.* (2023) hence describe how this idiosyncratic mode of "conservative innovation culture…aims to preserve socio-economic orders, rather than disrupt them" (p. 11). Controlling its development "like no other federal state" (Grüner, 2009, p. 5), the city-region's corporatist political culture fosters consensus through a systemically closed decision-making style among close-knit networks of influential institutions (Katzenstein, 1985). The region's economic prowess and historical industrial structure have however put considerable stress on urban development. Hence, Munich is facing challenges including growing social inequalities, increasing rental prices, a heavily car-centric mobility culture, insufficient digital infrastructures, and an overall pressure for greater sustainability and inclusive development. What is more, development initiatives in Munich and Bavaria have historically been top-down and economy-centric, with little room for public debate, civic participation, social justice concern or open dissent, which is regularly dismissed as unpatriotic towards the region's success model of techno-economic development (Berger, 2002; Pfotenhauer & Jasanoff, 2017; Pfotenhauer *et al.*, 2023). This heavy-handed, top-down approach to development marks an important contrast to other innovative German cities, most notably the notoriously unruly, artistic, and attractive Berlin—which has become a steady thorn in the side of Bavaria's proud success narrative. Consequently, the Bavarian state chancellery has identified a need for urban spaces that go beyond mere technological innovation, recognizing the potential of

creative (sub)cultures and demanding for more attention on their issues in an export report in 2013 (Tzschaschel, 2016).

Munich's recent history of creative (sub)culture and artist scenes could be described as one of increasing marginalization and displacement of bottom-up movements by more controlled, institutionalized modes of civic expression that accompanies the growing prestige and economic success of the city. Two constitutive moments of this history are the so-called "Schwabinger Krawalle"—sometimes viewed as Germany's entry point to the global ´68 anti-war student movement (Hemler, 2013)—and the local manifestation of the 1980ies Punk movement—featuring artistic and rebellious acts against heteronomy, conservatism and the posh and carefree "Schickeria" (Bayerischer Rundfunk, 2021; Dombrowski, 2021; Fischhaber, 2010). Both were met with police violence, and disproportionate penalizations such as long imprisonment periods even for under-aged activists. While Munich was the birthplace of the street art and graffiti movement in Europe until the late 1990s, this visual appropriation of public urban space (Kappes, 2014; Papenbrock *et al.*, 2018) was blatantly persecuted by both the city and the state administration (Krone, 2021; Nguyen, 2020). As the former Bavarian state minister Franz Josef Strauß promised in a speech in the 1980s:

> "Here in Bavaria, there is no space for squatters, slobs, anarchists, terrorists, and society innovators. Here at our place, no house squatting will survive even just one day!" (Bayerischer Rundfunk, 2021)

Against the constant pressure to stabilize socio-economic order, the formerly vivid creative (counter)cultures arguably lost much of their autonomous and rebellious character over time (Nguyen, 2020). Replaced by top-down institutionalized and commercialized creative actors such as the Positive Propaganda Association, urban art is now framed as a "good business that is worth investing in" (Moises, 2017). Today, critical voices and public perception regularly diagnose Munich with a subculture deficit or creative monoculture, that fails to provide space for alternative explorations of urban futures and instead confronts the remaining scene with the challenging reality of intermediate uses and economization (Hörmann, 2019; Kim, 2016). One columnist cynically concludes: "Munich does not need subculture, and if Munich needs subculture, Munich will buy subculture." (Borengässer, 2018)

It is in this overall context, that calls for "creative innovation" and a push for creative districts as urban transformation tools gained momentum. Our empirical work focuses on four creative district projects in Munich (see Figure 1), all launched since 2012.

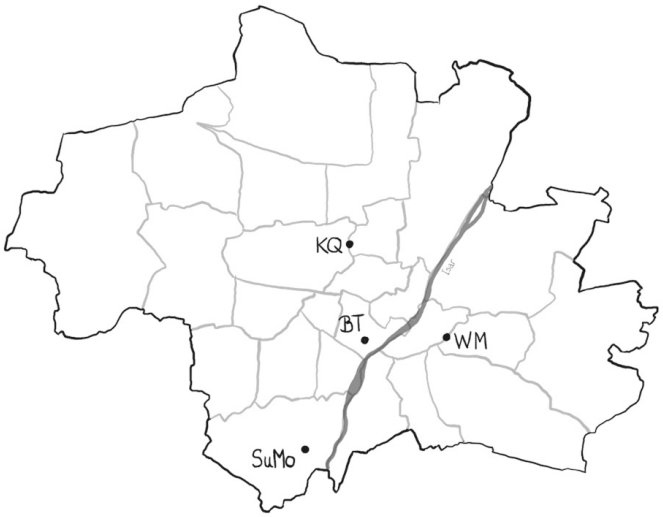

Figure 1. Sketched Munich map depicting the location of the four creative district sites (own sketch from the fieldwork).

With its core aspiration to balance financial and idealistic values by synergistically combining innovation and science with creative economy, subculture and art in an experimental field for new living and working models, the *Munich Kreativquartier* (KQ) won the city's urban development idea competition in 2012 (Landeshauptstadt München, 2021b). Since then, four interlinked yet independent areas are developed on the hitherto self-administered grounds of a historically grown community of independent artists, socio-economic and social justice NGOs, and DIY tinkering studios. Where "formal meets informal creativity", creative innovation shall imagine the city of the future and plant the seed that will transform into "Europe's Silicon Valley" according to Munich's former mayor Josef Schmid (Landeshauptstadt München, 2021a; Moises, 2017).

With a nod to the historic company premises of a traditional Bavarian dumpling factory, and its subsequent 20-year-period as home to Munich's club scene until 2016, eight independent proprietor parties have re-imagined the *Werksviertel-Mitte* (WM) as a "vision of a modern, innovative, and worthwhile city" (Werksviertel, 2020) by bringing together technology start-ups, co-working spaces, shops as well as ateliers. Sustainability measurements such as a green roof with sheep and bees, an on-site powerhouse and composting plant, and an e-car sharing model for residents underline its focus on (digital) innovation and public outreach in the name of ecological sustainability (Werksviertel, 2022b, 2024).

As an intermediate land-use concept from 2021 until late 2024, a three-member entrepreneurial company planned *Sugar Mountain* (SuMo) as a "happening place at the crossroads of culture, society and sports" (Sugar Mountain, 2022) that insists on its clear delimitation to urban development concepts based on digitization and technological innovation. Presenting creative innovation in the form of citizen-led events, and openly accessible sports infrastructure for kids and families on the grounds of a former concrete plant and Siemens-area, its core idea is imagined to remain as "Sugar Valley" in the subsequent development of hundreds of new offices and apartments in an integrated work-life concept (Zirnstein, 2024).

In 2015, a single private investor was granted a 10-year intermediate use contract for the art and culture project *Bahnwärter Thiel* (BT) on the grounds of the former slaughterhouse rail connection to Munich's cattle hall (Bahnwärter Kulturstätten GmbH, 2022), which was deemed rather unattractive by the city administration due to its lopsided grounds and deep railway ditches. BT was envisioned as a space of experimentation for local artists, workshops, and urban gardeners as well as nightlife, concert, and market space for the general public amidst the several dozen old subway wagons and sea freight containers—oftentimes titled the "last fallow for creative chaos" by columnists (Bremmer, 2016; Schubert, 2019).

2.3. THE PARADOXES OF MUNICH'S CREATIVE DISTRICTS

2.3.1. CURATION

In our fieldwork, we repeatedly traced how valued creative innovation would be carefully selected, staged, and instrumentalized. Aiming to radiate Munich's prestige and economic strength across borders (Tischer, 2016, 2020), it is primarily already established innovation players and hip marketable shops that receive institutional backing in Munich's creative districts. In the KQ, creative economists and integrated living spaces are budgeted with 99 million Euros (Landeshauptstadt München, 2021a), and the Munich Urban Colab—a collaboration between the entrepreneurial strand of the Technical University of Munich (TUM), the Munich city council, and influential DAX-listed companies such as the BMW Group or Infineon—constitutes the flagship initiative, promoted by the Munich Economic Department. The WM similarly foregrounds the number of new startup foundations with partnerships with the Silicon Valley to "stay ahead of the latest trends" in the innovation ecosystem (Werksviertel-Mitte, 2022b). The latest additions to SuMo are prominently funded by a nationally radiant soccer club and a sporting goods manufacturer, and many interviewees criticized the settlement of artsy but expensive shops as a "mere façade" that is "deeply entrenched in consumerism". Meanwhile, creative actors rooted in less

commercially viable scenes such as local artists, dancers, urban gardening projects, repair and political discussion cafés, tinkering spaces and youth establishments, have been driven out due to rising rental prizes or were not granted a lease extension, despite coining the area long before the official (re)branding as creative district, as one interviewee from a DIY workshop at WM remembers:

> "The leader board head would regularly host guided tours with some people from Japan or I don't know where, leading them through our workshop hall, and showing off how mutually fertilizing this is. But in the end, we were basically kicked out since we were not cool enough, not commercial enough, and could not afford the high rent anymore…It [the WM] calls itself the most start-up-friendly place in Munich, and yes, it might be start-up-friendly but it does not feel very creativity-friendly, at least not if you want to stay self-organized and autonomous."

Here, Scott's (1998) conceptual lens of "Seeing like a state" explains how what can be institutionally read as valuable creativity is determined by limited and economized measuring categories. According to Scott (1998), the belief in scientific and technological progress as motor for societal welfare explains state simplification and administrative attempts to order society in accordance with this belief. While the driving forces of the respective projects explicitly imagined creative innovation is as a joint endeavor, we observe that the value of creative practices and communities, for example, in terms of local meaning production and identity expression (Chapain & Sagot-Duvauroux, 2020) is not depicted and acknowledged in the development process. Consequently, alternative actors' respective visions of creative innovation through "structural reforms" and "changes of lifestyle and daily routines" (BT interviewees) rooted in maintenance and repurposing of work tools and spatial workplace are sidelined. During our conversations, most interviewees from alternative creative cultures even struggled to see their own value for the creative district projects themselves. This tendency results in a strong corporatization of Munich's understanding of creative innovation, with a dominant focus on creative economy, and high-tech urban transformation, usually in the field of smart city solutions. The aspirations for example became evident in actors' promotional declarations "to shape the city of the future while pushing Munich's high-tech start-up community" (Dr. Thomas, 2020; UnternehmerTUM GmbH, 2021), and both on-site and online stakeholders' push for "technology-driven" (Göhlich, 2020) approaches. Hereby, we encountered an almost religious devotion to creativity as key to efficiently realize the imagined technological solutions to urban challenges, as illustrated by the media use of the phrase "creative cathedrals" (Götting, 2021) to describe the creative districts. In this context, innovation operates as what Winner (2018) calls a *god term*—a rhetorical device that commands unquestioned authority.

In terms of the on-site aesthetics, we find a specific curation towards slick and expensive buildings, whereby critical voices both from creative scenes and the city council claim that the "mute and dead" industry-chic style hubs and fancy shops fit Munich's "tendency to cover everything in disinfectants, to be clean as a hospital", while leaving "no space for messiness". The following fieldnote excerpt underlines how the differing understandings of value become materially visible:

> Wandering through the KQ premises, I cannot help but notice the visual detachment from the area of the previously settled art and subculture scene (called creativity lab) and the area with the newly built Munich Urban Colab (called creativity platform). I first walk through the lab with its halfway torn down buildings and spot a consumption-critical graffiti spelling out the word "success" using the $- and the €-sign as well as the Gucci-logo. When I head towards the platform, I need to cross a massive construction site that splits one area from the other. Once I have passed it, it feels like entering a different district with the modern architecture of the Munich Urban Colab—a sign in one of the windows reads "We turn visions into value" with a little rocket on it.

Beginning in 2019, the city administration deployed the MGH[2], which legally operates as a capital company and thus adheres to profit-based decision-making, to administer the KQ area. Since then, local actors and critical city council voices moan a loss of autonomy whereby the former policy of self-administration and maintenance is pushed back. Buildings have been torn down over night due to "potential hazards and gainless renovation" from the city's perspective (Lotze, 2015), being replaced with rather expensive start-up containers that would "not match the needs of community-based organizations". Both here and at SuMo, conflicts occurred when residing artists (at KQ) or a residing urban gardening project (at SuMo) wanted to paint outside walls—in the KQ, the city administration declined the request and instead commissioned a Berlin design agency to decide upon the colors. Similarly, the somewhat chaotic appearance of the BT is fenced in by heavy concrete walls, hidden from the eyes of tourists and unknowing locals alike which enforces the impression that it does not fit into the city's established identity—as a residing DIY-tinkerer puts it: "No one would ever believe that this is Munich."

What is more, the increasing loss of "rather fucked-up spaces" where people have "room for failure" without being "scared to break something", and the and overall policy of renewal under a high utilization pressure would dictate the kind of controlled creative innovation that is allowed to happen in the districts, which matches academic research on spatial allowance for playfulness, messiness, and out-of-the-box-creativity (Steers, 2009).

[2] "München Gewerbehof- und Technologiezentrumsgesellschaft".

Taken together, our observations reveal a strong pattern of *curation* in the presentation, narration, and implementation of Munich's creative districts within the city's broader political economy and urban planning logics. This mechanism subjects creativity to a hegemonial valuation system based on variables of productivity and marketing.

2.3.2 COMPLIANCE

Against the background of missing institutional support and financial pressure, creative actors repeatedly moaned the limited potential for experimental and potentially subversive modes of expression. A representative of the WM Art Ltd, which was installed to manage the on-site art and creative culture efforts, hence stressed that projects such as their *Out-of-the-box-Festival* and exhibition on social transformation and urban development "needs to be aligned with the strategic district plans, it needs to be newly professionalized, distinguished and accurate" to match the overall WM "brand", its board is putting forward. Referring to themselves as a "tick in the fur" of WM, complying with the rules of the host animal—meaning not to disrupt the central social order of the economized idea of creative innovation—is vital. Rather than stirring ideological debate and disruption, art- and (sub)culture-based creatives are forced to buy into and to essentially mimic the established social norms of market-based innovation. When asked what the KQ stands for, a formerly involved artist provided the following metaphorical depiction of this change of creative cultures:

> "You know, for the longest time, there was this big red sign which was mounted high up in the air to one of the buildings, where the Munich Urban Colab is now situated. It read ´Mut` [German for ´courage`] in capital letters. We used to have MUT, now we have the TUM."

Instead of a space for collaborative experimentation with alternative urban futures, the urban gardening and co-working space *Radicchio Radicale* at SuMo moan how the district does not allow for radical rethinking, underscoring that the group's name is less rooted in radical activism but the goal to grow vegetables as well as a feeling of community in the seemingly hostile area of the former concrete plant that was dusted in concrete powder like powdered sugar:

> "I am myself employed in what you might dismissively call creative economy at the Werksviertel, and I hoped to build something here, that is somehow meaningful, where you just have the space to try out things, to learn new things, to think new thoughts. But at the end of the day, this is just as dependent on the patronage of one single man, so it also needs to conform. We are definitely more ´Radicchio` than we are ´Radicale`."

While SuMo's slogan "This is really happening" (Sugar Mountain, 2022) bears the notion of defiance and acting contrary to the established sociopolitical marching lines of Munich, we claim that its apparent success lies in its tame character, as underlined by one city council member's analysis that "Sugar Mountain simply does not hurt anybody.". The following quote from a KQ tenant sums up how an at least semi-stable position in Munich's creative districts is tied to the condition of not bearing too much subversive power, whereby the narrow way of seeing creative innovation like a state also implies the pressure to be seen by the state: "If you want to become part of the box [referring to a secure place in Munich, and thus the social state itself], you have to think inside the box [referring to the resulting form of creative innovation]".

Rather than pushing alternative forms of creative innovation rooted in counterculture and social reform, the unruliness of the remaining actors seems to lie in their attempt to stay part of the creative districts "against all odds" (WM interviewee). As we observed during city council debates on the KQ development, this however pulls individual administrative and funding questions to the forefront while pushing debates about the visions and practices of desirable creative innovation aside. With creative culture members being dependent on different city departments for public funding, the less market-oriented initiatives find their respective future more or less secured, and the differing departments would not only block each other's strategy but also operate on varying mismatching timelines. As underlined by one KQ interviewee's diagnosis that "everybody is fighting for themselves", the on-site efforts to communally coordinate different actors' interests and visions largely failed due to said aggravated fragmentation between involved institutions. This felt need for demarcation and individualization aligns with Reckwitz' (2017) analysis of a society of singularities which would feed into existing inequalities and polarizations.

What is more, Munich's creative districts paradoxically cultivate a perceived split between the different creative innovation scenes, avoiding potential conflicts rather than embracing them to negotiate urban futures, which leads the intended experimental character to absurdity. When a residing artist duo put the two works *AutoEater*—a vertical car being swallowed by concrete—and *The Smell of Revolution*—a burned-out car chassis—on the free of charge parking lot on-site of the KQ, the MGH charged them with monthly fees for blocking the space. What could have been an opportunity to discuss different visions on urban mobility with individualized e-mobility on one side, and the idea of a car-free city on the other, was hence quickly shut down. To put it in the words of Stirling (2008) when discussing discursive practices in Science and Technology Policy, this approach to creative innovation is "closing down" Munich's socio-culturally established technological

commitments whereby its automobile industry and respective solutions to urban mobility challenges are front and center.

It approaches urban challenges by fixing things in proven ways before allowing a debate on what is deemed broken by the local community, hence not "opening up" (Stirling, 2008) discursive negotiations between actor groups from different backgrounds. Verbally, our interviewees reinforced the detachment between technological innovation entrepreneurs and creative (sub)cultures of social innovation by repeatedly voicing that there was "zero overlap", and "no common ground", dismissively referring to each other's work as "some kind of business stuff" or "artsy occupation". In some cases, the interviewed actors did not even know about each other's existence, and with the insecure intermediate project temporality of many actors, decision-making lies with the established actors. Consequently, the creative district projects' goal of synergistically bringing together different creative innovation approaches seems stuck in a rather artificial realization, whereby different actors are "thrown together" without addressing existing hierarchies and inequalities in what interviewees have called a zoo-like or laboratory-like manner, critically calling it out as the "fairytale of the creative Bullerbyn". This ties back to academic criticisms of the creative class and the "add culture and stir"-mentality (Gibson & Stevenson, 2004, p. 78) with creativity as a goal in itself for innovation politics that however misses to debate its concrete goals and affects (see section 2).

Our empirics thus show a prevalent mechanism of *compliance* whereby creative actors are forced into alignment with rigid administrative procedures and Munich's established understanding of worthwhile creative innovation, if they want to stay or become part of the creative districts. This compliant enactment of creativity hinders the kind of bottom-up, holistic negotiations of urban creative innovation that the districts originally claimed to foster.

2.3.3 CONSOLIDATION

Being confronted with the mechanisms described so far, we encountered a narrow group of creative actors able to participate in the creative districts, filtered by structural demands that favor certain profiles over others. Especially among the less economically viable and less product-oriented creative actors, corporate support, political networking, and financial resources are existential characteristics, and our fieldwork quickly showed that it is the same few names that are re-appearing in the creative district projects. Both the BT and SuMo go back to very established initiators, who have made themselves a name in many creative culture interim and mid-term projects all over Munich. Accordingly, one of

the SuMo initiators stresses that one needs to have the network but also the money to enforce such a project, admitting that other young creatives might have better ideas but are lacking the resources. Along the same lines, initiatives such as Radicchio Radicale also consist of a very specific constellation of high-achieving Munich residents with well-paid jobs and extraordinary qualifications in the professional fields of financial investment, law, and marketing. On a podium discussion on constructing Munich as a worthwhile city of the future, which was hosted by the Munich Urban Colab in May 2022, said initiator of the Sugar Mountain project nevertheless appeared as the counter-voice to purely high-tech-based future-making and advocated for bottom-up urban development that is rooted in local and subcultural initiatives. During the event, he repeatedly pointed out that even himself as a man with exceptionally big resources in terms of finances and networks struggles to foster a space that allows for more society- and subculture-based projects, which highlights the excluding and consequently elitist mani-festation of what strives to be creative spaces in Munich. Other interviewees pointed to the prerequisite to "be able to play the game", that is to understand and work Munich's administrative and funding structures in one's favor. Most interviewees mentioned their academic background with many pro-actively citing Florida's idea of the creative class throughout our conversations, which in term confirms the built-in elitism in Florida's (2004, 2014) own conceptualization of the creative class as highly educated actors. At WM, sub-cultural and artistic actors are expected to deliver a long-term financing plan in the face of rising rental prices, thus calling for "another level of professionalization" (WM interviewee).

This narrowing of participation however recreates marginalization mechanisms in terms of gender, race, and class, so that non-male, non-white, non-academic, and non-capitalist perspectives on the meaning of desirable creative innovation remain underrepresented. One prominent example of the respective displacement is the so-called *Huberhäusl* at KQ, where refugees were included in creating and caring for a permaculture area that also offered space for artistic performances, and that was demolished without announcement or replacement due to structural instability. All things considered, the resulting remaining form of creative innovation is bound to reinforce Munich's social order of creative innovation, where high-tech- and profit-driven approaches spearhead the hierarchy.

Our findings hence point to a mechanism of *consolidation* through which an elitist group of well-connected, resource-rich, and professionalized creatives remain able to participate in Munich's creative districts. Rather than supporting a diverse creative crowd that represents different urban visions and needs, already marginalized voices are further excluded, narrowing the invited scope of transformative creativity and innovation.

3. CONCLUSION

How transformative can the turn to creativity in urban innovation policy and, more broadly, in economic policy really be? Our research finds that there are significant limits to how creativity can unleash innovation potential in socially desirable directions. Specifically, some of the most unruly and transformative elements of creativity are systemically held in check by an extant political economy. Through the lens of three cultivating mechanisms, we have seen the paradox effect whereby Munich's creative districts theoretically invite diverse creative cultures but practically safeguard the city's ingrained ways of urban future-making, while sidelining alternative practices such as maintenance, repurposing, and social reform-based approaches.

In keeping with existing analyses of regional innovation cultures in Munich, we find that creative districts as an instrument of innovation policy paradoxically tame the typically explorative, open-ended, subversive and potentially disruptive character of *both* innovation *and* creativity. We observe a form of *conservative creative innovation* that values creativity primarily as a driver of economic productivity in corporatist visions of high-tech transformation, and reigns in potentially disruptive thinking rooted in social justice and reform. It is governed through fragmented yet coordinated public and private actors whose timelines, priorities and spatial visions do not match the needs of the creative arts and subculture scene. This misalignment results in a perceived split between the respective creative cultures which prevents the initially intended communal negotiation of desirable urban innovation or creative practices and instead enforces a hierarchy of value and populations who are and who are not able to participate in urban future-making. While Munich's creative districts make the local innovation-paradigm seemingly more socially robust, they fail to acknowledge important socio-economic inequalities and recreate existing power hegemonies and marginalizations in terms of gender, race, and class.

In line with the conservative regional innovation culture, and the history of counter-culture in Munich, the conservative taming of creative innovation is imagined as a means to keep the prevailing success recipes intact and to tackle new challenges without having to drastically diverge from the established socio-economic trajectories—to ensure that "Bavaria remains stable" (Bayerische Staatsregierung, 2018). What remains is an extractivist logic of creativity and creative districts which frames creative (sub)culture as a pretty dress for the essential body of entrepreneurial innovation, that does not go beyond creative districts as a tokenistic branding tool (Evans, 2015), reminding of the rather outdated idea of art as a mere beautifier. Not only does this match the academic criticism of the

capitalization of culture, this form of creative innovation as a type of x-innovation also fails to break with the shortfalls of conventional political innovation economies (see section 2), wrongfully treating art and (sub)culture as external to the dynamics of innovation itself (Pfotenhauer *et al.*, 2023).

Our analysis shows that the control mechanisms shaping Munich's specific version of a creative innovation culture are not enacted and enforced by a single individual or group. They are rather deeply embedded in the institutional practices of the city administration, established technology companies, young start-ups, academic institutions, independent NGOs as well as the internalized logics and positionalities of creative actors across all fields. Throughout our ethnographic fieldwork, we encountered a widespread sense of frustration about recognizing yet being unable to escape the conditions under which creativity gets enacted, much in line with what other scholars have diagnosed as the hegemony of technocratic development strategies (Anderson *et al.*, 2007; Macq *et al.*, 2021). With corporate innovation strategies and quantitative market measures dictating what can be read as valuable creativity and by whom (Scott, 1998), our research aligns with Parthasarathy's (2022) conclusion how a more holistic approach of inclusive innovation is trapped in existing political economies that limit its transformational power.

Our research both confirms and goes beyond critical analyses of Florida's ideal of a creative class. On the one hand, we observe how visions of collaborative and systemic creative innovation are based on the fundamentally wrong assumption of equal and symmetrical standings of creative actors in economic and innovation contexts. On the other hand, our case study reveals how creative districts, and the creativity-oriented innovation economy do more than simply enact well-known patterns of commodification and gentrification. Rather, we have seen how creative districts co-configure and stabilize certain entanglements of innovation, creativity, and urbanism in relation to one another under a broader umbrella of a common good, shaped in turn by extant socio-political settlements in a region.

Furthermore, contrary to Florida's work, we find that the relationship between creativity and innovation—and hence the transformative potential ensuing from it—is centrally mediated through the state. This might be particularly visible in the case of Munich, where the city administration is both relatively well-funded and a ubiquitous actor, and where the infrastructures and purposes of both innovation and creative cultures are actively steered by the state (Pfotenhauer *et al.*, 2023). However, this relation to the state is a key juncture for all creative districts, especially when looking at transformations, public

interest and the constitution of citizens-state relationships (Juhl *et al.*, 2025; Macq, 2021; Pfotenhauer & Juhl, 2017). Further research should investigate whether this is a more generalizable verdict on the promise of creative districts or simply the logical progression of the locally stabilized conservative innovation culture in Munich.

Finally, feminist STS sensibilities remind us to be attentive to who is in power and how this power translates into *response-ability* when facing dynamics of exclusion and subjugation (Barad, 2012; Haraway, 2007). In Bavaria and particularly in Munich, creativity remains a staple for imagining worthwhile urban futures—in 2023, the city administration launched the co-creational NEBourhoods project with creatives as central players to re-imagine a city district as part of the EU New European Bauhaus movement (Architekturgalerie München e. V., 2023) just shortly after establishing the Competence Team for Cultural and Creative Economies (Munich RAW, 2024). Recognizing the problematic implications of different creative cultures increasingly drifting apart, a Bavarian study on cultural and creative industries concluded that solution to this widening rift was for the subculture and art scene to orient itself towards the technology-based creative economy (IW Consult GmbH and Cultural Policy Lab Research Services, 2021). However, if we want to allow creative districts the potential to truly act as "hybrid forums" (Callon *et al.*, 2011) that foster transformative synergies between diverse creative actors and practices, we underscore the importance to establish active state mechanisms to counter the limitations of conservative enactments of creative innovation. As Robra *et al.* (2023) put it, convivial innovation rooted in commons-based efforts can only co-emerge with a supportive state.

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Steering the Course

Negotiating Directions in Alternative Research and Innovation Policies for Transformative Change

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ABSTRACT

This paper explores how inclusive and environmentally focused research and innovation policies challenge dominant models by reshaping directionality and governance for social transformation. It contributes to Critical and Transformative Innovation Studies by addressing key intertwined gaps: the role of agency, the political economy of policy instruments, the politics of continuity, and its territorial grounding. Analytically, it expands a Knowledge Systems approach, promoting a broader, symmetrical view of innovation that values diverse actors, policies, infrastructures, and knowledges. It challenges competitiveness-driven assumptions by exploring how alternative normative directions are negotiated over time. Through two case studies in Argentina—*Yogurito* (a probiotic yogurt to address malnutrition) and the *Paraná River Aquarium* (focused on biodiversity conservation)—the paper traces innovation journeys as a process where multiple actors vie to steer its course. Directionality is framed as both a political process of prioritization and decision making amid competing interests and its negotiated outcome, shaped by actors' visions, knowledge, and policy preferences. The paper also proposes a framework to empirically trace and analyze these evolving pathways. It shows how innovation is steered, which orientations take precedence, and the limits and possibilities of STI as a development driver under enduring structural constraints.

Keywords: Critical Studies of Innovation; Science Technology and Innovation Policy; Transformative Innovation Theory; Mission Oriented Policies; Directionality; Technology Governance.

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INTRODUCTION

Innovation is often heralded as a universal driver of economic growth and a pathway to sustainable, inclusive futures. As Innovation Policy evolved from a theoretical framework to a key policy rationale, it merged diverse policy and technological approaches into a unified, fast-paced "speed politics" (Armitage, 2000) designed to capture markets.

In response to its competitiveness bias, in recent years a "normative turn" (Schlaile *et al.*, 2017) sought to reorient innovation policy toward addressing urgent societal challenges. This shift has generated a proliferation of "X-innovation" frameworks (Gaglio *et al.*, 2019) to amend this bias—from social (Howaldt *et al.*, 2019), sustainable (Boons and Batista Navarro, 2021), inclusive (Heeks *et al.*, 2014), responsible (Owen *et al.*, 2012) to transformative (Schot and Steinmuller, 2018), among others—each reflecting distinct normative goals. These alternative concepts evolved into normative policy models and orientations (Gaglio and Vinck, 2021) offering preferred instruments and infrastructures to steer innovation toward desirable futures (Lascoumes and Le Gales, 2007), while also contributing to the global circulation of institutional models and isomorphic trends (Peck, 2011; Aguiar *et al.*, 2017; Pfotenhauer and Jasanoff, 2017b).

Research shows that policy instruments often take on a life of their own, shifting focus from intended goals to their own operation (Lascoumes and Le Galès, 2007; Ureta, 2023). This inversion of means (i.e. policy instruments) and ends (i.e. policy goals) frequently reveals an implicit competitiveness bias embedded in instrument design, undermining stated social aims (Bortz and Thomas, 2019). Numerous case studies highlight these theoretical and policy shortcomings (Thomas *et al.*, 2017; Ureta, 2023). Despite the persistence of linear models in R&D (Joly, 2010) and the dominance of systemic approaches in policy (Aguiar *et al.*, 2017), empirical evidence shows that interventions often yield isolated, product-oriented outcomes (Thomas *et al.*, 2017; Bortz and Thomas, 2019). Little attention is given to how actors, infrastructures, and processes interact in practice to drive transformative change—reconfiguring systems of production, consumption, and governance to address societal and environmental challenges (Schot and Steinmuller, 2018; De Graaf *et al.*, 2025).

Recent debates have renewed attention on the governance and directionality of innovation—i.e. the normative orientation of sociotechnical change (De Graaff *et al.*, 2025) —driven by academic critiques of innovation's unfulfilled social promises (van Lente, 2012; Pfotenhauer and Jasanoff, 2017b; Godin *et al.*, 2021) and a growing policy trend toward state-led, mission-oriented innovation (Hekkert *et al.*, 2020; Mazzucato, 2021). Yet, while

most analysis focus on systemic directionality, they often overlook the agency shaping transformative goals—that is, direction-setting as a political process and outcome of prioritization and decision making (Majone 1989). This includes who steers, how power asymmetries shape decisions and policy preferences, and how agency is enacted through materialities and infrastructures that influence resource allocation and crystallize policy orientations (Stirling, 2008; Godin *et al.*, 2021; De Graaff *et al.*, 2025). This is particularly evident in the politics of trade-offs between societal and market-driven innovation goals (Grillitsch *et al.*, 2021).

This paper explores how alternative research and innovation (R&I) policies—addressing inclusion and environmental challenges—navigate, contest, and reshape dominant models by negotiating directionality and governance in pursuit of social transformation. By "alternative", we refer to R&I policies that diverge from mainstream industrial or tech-driven approaches, prioritizing goals beyond competitiveness and economic growth (Godin *et al.*, 2021). Through two quasi-experimental case studies in Argentina—the school probiotic yogurt *Yogurito* and the *Paraná River Aquarium*—, the paper examines tensions within local R&I agendas, highlighting conflicts between dominant models and territorially grounded technoscientific practices shaped by local agency.

These cases allow to address key gaps in critical and transformative innovation studies (Grillitsch *et al.*, 2021). First, they make visible the role of agency—who steers directionality and how. Second, while research often emphasized innovations' origin, it overlooked how innovations are sustained, adapted, and negotiated over time (Jackson, 2014; Grillitsch *et al.*, 2021). The cases shed light in the politics of continuity along uncharted innovation journeys (Van de Ven, 2017) and how these intersect with or diverge from mainstream approaches (Dias, 2013).

Third, the cases bring essential territorial sensitivity, often lacking in transformative innovation policy studies, especially regarding regional dynamics in the Global South (Grillitsch and Asheim, 2018). They exemplify early, self-assembled mission-oriented subnational policies—even predating the term's popularization—pursuing bold measurable societal goals through cross-sector innovation and investment for inclusive and sustainable outcomes (Mazzucato, 2021). These cases illuminate how local actors negotiate orientations, market and non-market dynamics, public goods, and services in context-specific ways. They also bring a Latin American perspective largely absent from transformative innovation frameworks and mission-oriented policy studies, not only enriching theory but translating it into practice, revealing lessons from varied regional contexts (Gaglio and Vinck, 2021).

Analytically, this paper calls for a broader view of innovation systems—one that embraces diverse knowledge bases, purposes and directions. Through an iterative dialogue between theory and empirics, we show that directionality is not a fixed endopoint but a continuous negotiation shaped by the shifting interaction of actors, knowledge, policies, and infrastructures. We also show that even when policy goals may remain stable, the paths to achieving them evolve through ongoing micropolitics that reshape both policies and technologies. Using two seemingly virtuous cases of transformative innovation, we also expose the limits of framing STI as a development driver within the structural constraints of the Global South.

1. INNOVATION SYSTEMS, WHERE TO?

1.1. CONTESTING INNOVATION SYSTEMS

Innovation is often tied to values and promises of better futures, accompanied by optimistic claims about its societal benefits (van Lente, 2012). Framed as essential for market competitiveness and economic growth, or even equated to progress itself, it has become an unquestioned policy imperative and the ultimate road to solve pressing societal challenges (Godin *et al.*, 2021; Pfotenhauer and Jasanoff, 2017b; OECD, 2015). Innovation systems theories (Lundvall, 1992; Edquist, 2004) emphasize the role of supportive structures —education, infrastructure, and policy—in fostering innovation, promoting the belief that well-designed systems inherently drive economic success that translates into aspired visions of "common good" (van Lente, 2021).

Since the 1990s, innovation systems approaches shaped both theory and policy, advocating coordination among firms, governments, R&D institutions, and finance to drive growth (Lundvall, 1992). Though developed in high-income countries, it was adopted in Latin America as a forward-looking policy model through international policy agencies and experts, adapted to local contexts (Arocena and Sutz, 2001; Aguiar *et al.*, 2017). As it became more prescriptive, the model emphasized its set of preferred standard tools—from technology transfers, public-private partnerships, technological parks, incubators, to accelerators and start-ups—and privileged actors—firms as the main innovation drivers, connected to universities and R&D institutes, and supported by a growing network of intermediary and support organizations (Suárez and Erbes, 2021).

STI's 21st-century "normative turn" recast its social contract to confront equity and environmental challenges (Lubchenco, 1998; Daimer *et al.*, 2012), with R&D agendas following suit under the 2030 Agenda's call to address distribution, governance, and sus-

tainability (Leach *et al.*, 2018). However, sustained scholarship has shown the unevenness of these expected benefits and limited impact on equity, often treated as a spillover rather than a primary goal (Mazzucato, 2013; Leach *et al.*, 2010). Even efforts to leverage innovation for inclusive and sustainable futures, frequently ignoring regional disparities, ended up reinforcing inequalities (Thomas *et al.*, 2017; Bortz and Thomas, 2019; Suárez and Erbes, 2021).

Amid structural inequalities, the early 2000s saw the rise of "X-innovation" approaches (Gaglio *et al.*, 2019) targeting marginalized populations, especially in the Global South. These ranged from pro-poor market approaches—treating low-income groups as underserved consumers and even growth engines (base-of-the-pyramid, Prahalad, 2010; below-the-radar, Kaplinsky, 2011; frugal innovation, Radjou *et al.*, 2012; or grassroots innovation, Gupta, 2003)—to social problem-solving via individual action, social entrepreneurship, cross-sector collaboration, and engaged university outreach (Edwards-Schachter, 2021). These approaches largely aimed to spur pro-poor innovation, without challenging the structural dynamics of production, consumption, or distribution (Thomas, *et al.*, 2017). In the 2010s, they converged as inclusive innovation (Heeks *et al.*, 2014), blending social and technological efforts through both grassroots and top-down initiatives to advance—rather restricted—aims of inclusiveness and sustainability.

Yet, these initiatives relying on standard innovation tools—like tech transfer, public-private partnerships, entrepreneurship—often produced solutionist fixes misaligned with local needs and broader policy (Thomas *et al.*, 2017; Bortz and Thomas, 2019). This exposed a gap between understanding inclusion as access to goods and deeper demands for structural and epistemic change (Heeks *et al.*, 2014; Bortz and Thomas, 2017; 2022). Policy choices tended to favor the former, overlooking the material, political, and economic dynamics embedded in instruments. As a result, competitiveness-driven tools poorly adapted to inclusive ends, often reinforcing inequality rather than enabling transformative change (Lascoumes and Le Galès, 2007). This calls for rethinking not just tools and infrastructures but the broader political economy of R&I (Tyfield *et al.*, 2017)—who sets directions, controls resources, selects preferred instruments, and defines what inclusive transformation means and how it is actually pursued.

These shortcomings have sharpened debates on innovation "directionality" (Schot and Steinmueller, 2018), revealing weak collective mechanisms for setting priorities and choosing development pathways. While policy and scholar debates have—more often than not—technicized innovation policy as a matter of enhancing instrument choice, finding the "best tool for the job" (Lascoumes and Le Galès, 2007), directionality reveals

as inherently political: trajectories reflect competing interests and power relations that negotiate normative aims—such as competitiveness, sustainability, or inclusion and what they entail (Leach *et al.*, 2010; Schot and Steinmueller, 2018). It comprises both system assessment—how it works and to what ends—with the politics of steering toward desired futures following shared visions, forging consensus on priorities, and cross-level coordination (Joly, 2010; Hekkert *et al.*, 2020).

This renewed emphasis on directionality neither makes STI policy newly "directional" nor lends itself to ratings like lacking/weak/strong (Bulah *et al.*, 2024). Rather, it highlights that all policies—whether curiosity-driven, competitiveness-oriented (with implicit directionality), or mission-driven (with explicit goals)—are negotiated political settlements shaped by unequal power within and beyond the policy arena (Majone, 1989; De Graaff *et al.*, 2025).

Following Van de Ven's (2017) analogy, innovation journeys can thus be imagined as navigating uncharted waters—it entails manouvering through messy, nonlinear paths in converging and diverging currents. Building on Van De Ven's metaphore for increasing "the odds of maneuvering" to reach intended goals (2017, p. 4; Kuhlmann, 2012), we suggest that innovation is not a vessel with a single captain, but one where multiple actors contest the governance wheel, each seeking—explicitly or implicitly—to steer direction through shifting waters.

Analyzing how innovation is steered and toward which goals, or why some directions prevail over others, involves assessing power assymetries, knowledge bases, trajectories, investments, and governance beyond sectoral priorities, linking them to broader sociotechnical change (Geels, 2004). It also requires revisiting the state's role: governments may privilege sectors tied to national interests over broader welfare goals, and direction-setting creates winners and losers (Mazzucato, 2013; 2021). Room to manoeuvre depends on actor legacies, their embedded networks, policy structures, and fragile consensus, as past choices generate lock-ins and dominant designs that narrow future pathways (Stirling, 2009; Bulah *et al.*, 2024).

1.2. KNOWLEDGE SYSTEMS FOR TRANSFORMATIVE CHANGE

The growing innovation studies literature to address societal challenges increasingly centers on systemic transformative change (Schlaile at al., 2017; Schot and Steinmueller, 2018), shifting from early 2000s' narrow focus on inclusion in developing contexts (Heeks *et al.*, 2014) to addressing the global interlinkages of equality and sustainability. This reorientation calls for rethinking categories, visions, and instruments for structural transfor-

mation, while recognizing diverse pathways shaped by local specificities. It emphasizes cross-actor collaboration and the influence of cultural, social, regulatory, and infrastructural factors, stressing the importance of aligning STI policy with broader national strategies.

However, it faces analytical and empirical gaps that open avenues for further research (Grillitsch *et al.*, 2021). First, while *agency* is acknowledged in niche management (Geels, 2004) and user roles (Schot and Steinmueller, 2018), its role in steering transformative change remains underexplored beyond the niche level (Bortz and Thomas, 2022). Though highlighted conceptually (De Graaff *et al.*, 2025), it still lacks empirical depth and specificity. Overlooking actors' effective capacity for action and negotiation, who participates, who holds influence and how they define priorities and policy preferences, limits our understanding of how STI systems are created and transformed in practice and over time.

Second, the role of *policy processes and instruments* remains underexplored, particularly how policy mixes—comprising tools, institutions, rules, and procedures—align with context-specific transformation goals, and how policy preferences are shaped. This calls for selecting tools suited to local needs rather than following global policy trends (e.g., past public-private partnerships, or current missions and entrepreneurship) (Peck, 2011; Aguiar *et al.*, 2017). Instrument choice shapes not only knowledge production but also who is invited to participate and holds influence, reinforcing specific policy preferences and who benefits from it (Lascoumes and Le Galès, 2007). When poorly matched, inclusion-oriented policies can deepen exclusion (Bortz and Thomas, 2019), while context-sensitive mixes can foster inclusion by engaging non-state and informal actors and amplifying marginalized voices and expertise (Bortz and Thomas, 2017).

Third, the knowledge base driving transformation, encompassing not only the knowledge enabling diverse technological pathways, but also the expertise shaping policy and instrument design. This raises questions about expert advice in innovation policy, often confined to a narrow expert community and treated as technical rather than political matter (Aguiar *et al.*, 2017; Ureta, 2023).

Fourth, while recognizing their importance, transformative innovation analyses have often underexplored *local and territorial dynamics*, particularly how policies unfold across geographical contexts (Grillitsch *et al.*, 2019). In many low- and middle-income countries, limited institutional capacity to shape directionality is not always reflected in frameworks from high-income settings. Empirical studies across diverse regions can help adapt and enrich these approaches, especially at the regional level (Suárez and Erbes, 2021).

Finally, while much research focuses on the origins of innovation—privileging design, production, and early adoption amid a broader "predilection for the new" (Jackson, 2014, p. 234)—less attention is paid to maintenance, adaptation, and long-term transformative effects (Laurent, 2021; Grillitsch *et al.*, 2021). The "timeliness of technology" (Jackson, 2014, p. 234) underscores how contingent, often-invisible efforts of repair and upkeep are crucial for making innovations—whether technologies or policy instruments—enduring. Attending to these processes introduces the *politics of continuity*, enriching the temporal narrative of both innovation journeys (our vessel and its disputed path) and institutional structures (the shifting riverbed, its dams, canals and embankments), marked by power struggles, and foregrounds how alternative projects intersect with or diverge from dominant pathways over time.

To address these concerns, we explore the concept of transformative knowledge systems (KS) (Cash, 2003; Cornell *et al.*, 2013; Atela *et al.*, 2021) to shift the focus beyond innovation-led goals toward embracing broader policy and technology choices. This expands the traditional STI framework by including both formal and informal knowledge actors and embracing diverse transformation goals beyond growth and competitiveness —often embedded in "innovation" as a prescriptive near-belief system, with its preferred tools and privileged actors (Godin *et al.*, 2021; Winner, 2018). It highlights a range of often-overlooked components essential for inclusive development, from social and territorial networks, communities, movements, informal institutions, to traditional knowledge.

Knowledge systems (KS) encompass networks of formal and informal actors, practices, and institutions involved in producing, sharing, and using knowledge (Cornell *et al.*, 2013). Emphasizing the networked, relational, negotiated, and contextual nature of knowledge, this approach fosters co-creation between scientists and societal actors (Cash, 2003; Cornell *et al.*, 2013), link diverse ways of knowing and collaboration (Bandola-Gil *et al.*, 2023), and shape flows of credibility and power (Jasanoff, 2004). Co-creation is central to addressing sustainability challenges, requiring open systems that integrate varied knowledge sources and recognize the role of territory, agency, and both market and non-market forces in shaping STI systems (Cornell *et al.*, 2013; Bandola-Gil *et al.*, 2023). Though still evolving, this definition offers a valuable lens to examine how systemic orientations—whether toward competitiveness, inclusion, or sustainability—are negotiated. Making these arrangements visible helps reduce implicit biases and better align[1] diverse knowledge

[1] Misalignment between policies, capacities, and objectives is evident when goals like inclusion or sustainability are unmet, resulting in unintended outcomes—dual economies, exclusion of target groups, or poorly targeted technological solutions. As discussed earlier, many inclusive innovation efforts fell short, with policies and trajectories often contradicting their own stated aims.

(local and generalized, informal and formal, lay and expert, tacit and explicit, traditional and scientific) and capacities (S&T, industrial, political, regulatory, among others) with societal goals, guiding more effective interventions (Frost *et al.*, 2020; Atela *et al.*, 2021).

Building on this definition, and to deepen this analytical lens, we identify five key dimensions for empirical analysis following the intertwinned gaps identified above: (1) *the role of actors and agency*—who participates in transformative change and with what influence over the innovation process; (2) the *knowledge base informing policy and technology design*, as both co-construct transformation, as technological choices—what, for whom, and how—reflect values and power dynamics and co-evolve with policy choices, shaping the direction and inclusiveness of change; (3) *policy processes and instrument mixes*, aligned—or not—with transformation goals; (4) the *politics of continuity*, capturing adaptation and reconfiguration processes; and (5) the *identification of directionalities*. Building on the literature reviewed above, we may distinguish five main directionalities: (i) basic science, shaped by historical research norms (Polanyi *et al.*, 1962; Rip, 1994); (ii) competitiveness and growth, central to innovation systems thinking (Lundvall, 1992; Edquist, 2004); (iii) poverty alleviation, as in inclusive innovation (Gupta, 2003; Kaplinsky, 2011); (iv) sustainable growth, combining green sociotechnical transitions with competitiveness (Kivimaa *et al.*, 2021; Cressman, 2019); and (v) transformative development, integrating sustainability and equality (Thomas and Santos, 2017; Schot and Steinmueller, 2018). Together, these dimensions reveal how actors and knowledge co-produce visions and shape policy preferences, influencing who participates, how change unfolds, and in which direction.

Figures 1 and 2 map the framework as radars charting the diverse "journeys" (Van de Ven, 2017) each vessel may take—whether strictly innovative or not. Figure 1 presents three concentric circles: knowledge bases (inner circle), the actors and institutions that produce and mobilize them (middle), and the policy preferences and choices they shape (outer). The different elements included in the circles emerged inductively, from the evidence collected during the empirical work (see Methods), complemented by the literature review. Directionality—represented by the outward-pointing arrow—captures both the desired orientation these actors through knowledge and policy steer, and the negotiated result of interactions across these layers. Figure 2 builds on this by outlining the five directionalities stylized above (i-v), showing how actors, goals, policy instruments (with their material anchoring), and outcomes are tightly interlinked.

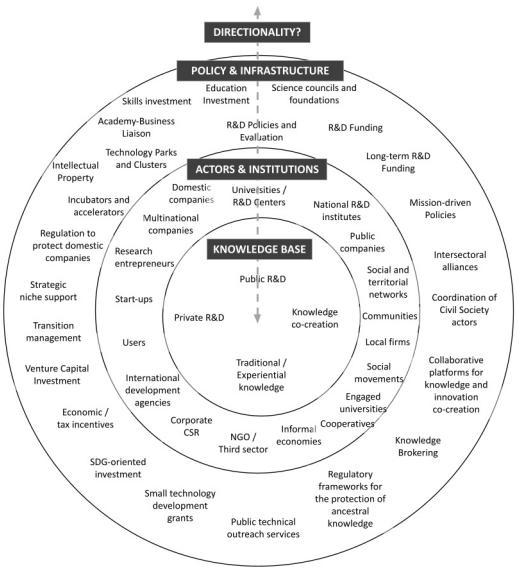

Figure 1. Knowledge System mapping.

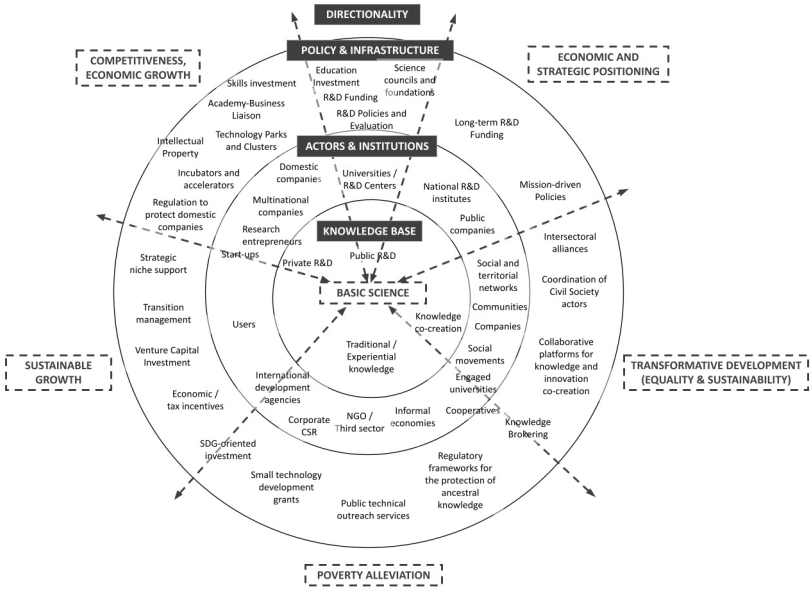

Figure 2. Knowledge systems directionality mapping.

2. METHODS

This study adopts a qualitative, cross-case approach to analyze "innovation journeys" (Van de Ven, 2017) as a way to challenge dominant theories and support alternative conceptualizations (Gaglio and Vinck, 2021). The concept captures the open-ended, uncertain, and negotiated nature of sociotechnical change—marked by detours, shifting goals, and no fixed endpoint. It foregrounds agency as actors navigate evolving institutional contexts, the precise path evolving as travelers gain knowledge and experience (Geels *et al.*, 2008). Originally used to examine how new ideas emerge and evolve within changing organizational settings (Van de Ven *et al.*, 1999; Geels *et al.*, 2008), we extend the concept to trace innovation journeys within broader regional and national knowledge systems.

Case selection draws from a 2013–2017 survey of 66 biotechnology projects addressing social issues in health, food, and environment (Bortz, 2017), followed for a decade. We focus on two long-term initiatives: (1) *Yogurito*, a probiotic yogurt program tackling child malnutrition prompting a local development strategy, and (2) the *Paraná River Aquarium*, a regional center for biodiversity conservation and its sustainable use. Both cases involve diverse actors (scientists, policymakers, producers, civil society), pursue explicit transformative goals, are regionally embedded, have over 20 years of continuity, and yield both marketable and non-marketable innovative outcomes.

We used a constructivist grounded theory approach (Charmaz, 2006; 2016) with an open-ended, iterative design linking data and theory. Data collection included 25 semi-structured interviews across both cases (*Yogurito*: 15 interviews—13 from 2013–2015, 2 in 2024; *Aquarium*: 10—1 in 2013, 6 in 2019, 3 in 2023–2024), identified through snowball sampling. Informal conversations with key informants complemented the interviews. Observations included participatory sessions at guided exhibitions (2015, 2019) and non-participant visits to laboratories and government offices. We also analyzed documents such as project files, policy plans, media, technical reports, academic articles, websites, and CVs. All data were transcribed, coded, and inductively analyzed to connect empirical insights with theory.

The next section reconstructs the innovation journeys of *Yogurito* and the *Paraná River Aquarium*. While deeper case analyses appear elsewhere (Bortz and Thomas, 2017; Bortz, Gázquez and Santos, 2022; Gázquez, 2024), we focus here on key phases marked by directionality shifts. These reflect changes in power dynamics, actor constellations, and evolving uses of policy and infrastructure. Preferences—like technology transfer or multi-actor forums—often emerged from engagement with dominant instruments of the

time. Due to space limits, each phase is presented as a snapshot of critical negotiations between actors, knowledge, and policy.

3. EXPLORING ALTERNATIVE INNOVATION JOURNEYS

3.1. "YOGURITO" SCHOOL YOGURT

The *Yogurito* School Yogurt is a probiotic yogurt developed to prevent diseases linked to child malnutrition in Tucumán, Argentina's smallest province, long struggling with poverty and inequality (Figure 3a). Created by the public R&D institute CERELA (Research Center for Lactobacilli), affiliated to the National Science Council (CONICET), and produced by a local firm with government support, it became a flagship example of inclusive innovation for national STI authorities (Bortz and Thomas, 2017).

Phase 1 (1980s). In 1984, doctors at a children's hospital in Tucumán turned to CERELA to help reduce infant mortality in malnourished children after a severe diarrhea outbreak. Leveraging immunomicrobiology expertise, CERELA scientists developed "Cerela milk," an early innovative probiotic formula using Lactobacillus strains to restore gut flora and improve immunity in malnourished children (Perdigón *et al.*, 1986a; 1986b). The success positioned CERELA as a regional probiotic leader. A joint patent with domestic firm SanCor and Danish food ingredient firm Christian Hansen[2] led to the transfer of this technology in 1988 and the 1995 launch of "Leche Bio" amid an emergent functional food market[3], being considered a great early success of CONICET's recently created technology transfer office (Figure 3b). However, as a commercial product, it diverged from its original public health mission and never reached its intended beneficiaries (Lorenzano, 1995; Bortz *et al.*, 2018). As CERELA's former director expressed this dual perspective:

> "*Leche Bio* is often cited by S&T actors as a successful case of technology transfer: public R&D turned into a mass-market product by a national company (…) [It] brought us great satisfaction, nationally and abroad. It led to a patent between SanCor and CONICET and became a commercial product (…) one with enormous future potential." (Oliver, 1994)

> "Still, it's disheartening. This milk—which treats diarrhea and child malnutrition—has been in the market for seven years and is selling more every day. Yet in Tucumán, it was never officially promoted or used as it should have been in a province with so much poverty…" (*El Siglo*, Jan 24, 2013)

[2] Under the agreement, CERELA received royalties, SanCor held the patent, and Christian Hansen had exclusive rights to sell the probiotic internationally. However, SanCor had to transfer the production and industrial-scale strain multiplication to Christian Hansen's headquarters in Denmark (Gutman and Lavarello, 2014).

[3] Some stakeholders attribute this delay to the time needed to scale from pilot to industrial production, others to the limited domestic demand for functional products, which were still uncommon in the 1980s.

Phase 2 (2003-2007). Argentina's 2001 crisis plunged over half the population into poverty, exposing the deep social exclusion caused by decades of deregulation and market-driven policies. In Tucumán, poverty reached 60%, with malnutrition and public health crises making national headlines. In response, CERELA researchers revisited the idea of a probiotic food for child malnutrition, building on lessons from *Leche Bio*. After two decades of research, they identified *Lactobacillus rhamnosus CRL 1505* as a promising strain to strengthen immunity in malnourished children.

As the crisis eased, and amid a broader expansion of participatory tools in social and development policy in early '2000 (Cornwall and Brock, 2005), the national STI Secretariat (SECyT) launched regional multi-actor forums to tackle local issues. At the Northern Argentina forum, CERELA collaborated with producers, NGOs, and policymakers to co-design a probiotic yogurt for vulnerable children. By 2006, CERELA had completed the laboratory set-up, but testing immune effects required a clinical trial. With support from Tucumán's STI agency (SIDETEC) and the provincial Ministry of Social Development (MSD), CERELA secured SECyT funding (~USD 12,000) to run a clinical pilot—marking the yogurt's first step beyond the lab.

> "Malnutrition on our doorstep made us rethink our role (…) we couldn't just stay locked in the lab." (*El Cronista*, Oct 22, 2009)

> "*Social outreach* was a *debt* we had. That's why, from 2003, we began thinking seriously about transferring science to society." (CERELA director, 2013, interview)

Phase 3 (2007-2008). With SECyT funding, CERELA led a double-blind trial involving 298 children (ages 2–5) in vulnerable peri-urban kitchens in Tucumán. Over 150 people were engaged—MSD officials selected the kitchens based on accessibility and trusted local connections, while nutritionists, kitchen staff, social workers, dairy producers, and provincial health doctors engaged with families and monitored health conditions. The trial also involved reformulating the yogurt based on children's taste preferences. The ferment was manufactured in CERELA's facilities. Trial results showed stronger immune responses (34% vs. 66% in placebo group) (Villena *et al.*, 2012), attracting national media coverage. The current principal investigator recalls:

> "Everyone who heard about it, even in the early clinical studies (…), started to get involved." (…) "We focused on the outskirts—where needs were greatest—and began in community kitchens, since accessing schools was more complex. These kitchens operated in the homes of people living in poverty". (…) "It was a powerful learning experience beyond the science. Working in the field affected us deeply (…) became part of the study's outcomes: not just the increase in IgA (…) or reduced infections, (…) but also creating new eating and hygiene habits, cross-sector coordination, and training for kitchen staff, who adopted better food handling practices. The impact went far beyond our initial scientific goals." (*Yogurito*'s PI, 2024, interview)

Phase 4 (2008-2011). Following the trial's success and widespread media coverage, Tucumán's Ministry of Social Development (MSD) decided to reallocate funds from the *Copa de Leche* ('Milk Cup') school food program to launch *Yogurito*. In 2008, the province invested ~USD 1 million to provide the yogurt three times a week to 56,000 children in public primary schools, scaling to 100,000 in 2009 and 200,000 by 2010, becoming a pillar of provincial food policy (Figure 3c). *Yogurito* became a cornerstone of provincial food policy, steered by the MSD and CERELA, addressing child malnutrition while aiming to revitalize the local dairy sector.

Scaling required coordinated implementation across MSD, CERELA, the Ministries of Education, Health, and Production, local dairy farmers, and a yogurt small manufacturer. It also required organizing production and delivery (milk supply, processing, and expanded ferment output from CERELA), training school staff, and setting up a health monitoring network through primary care centers. A key step was CERELA's pilot plant, funded by reinvested royalties. Drawing lessons from *Leche Bio*, instead of transferring, CERELA kept control of ferment manufacturing, preserving the project's governance to assure the alignment of goals, means and results:

> "Accessibility was emphasized by officials and producers to *distinguish* it from *Leche Bio* a probiotic ferment that *ended up with 'a large company'* and was *sold at high prices*." (*La Gaceta*, 2014)

Collaboration during the 2007–2008 trial led to the 2008 creation of the Intersectoral Board on Health and Nutrition, building on MSD's participatory management experience. Meeting weekly, the Board aligned policies across health, education, production, and social development. Given *Yogurito*'s complexity, public investment and exposure, and CERELA's scientific role, strategic coordination was key. The program drove institutional shifts—reallocating *Copa de Leche* funds, increasing milk demand, reorganizing supply chains, and reorienting CERELA toward industrial-scale probiotic production.

Yogurito allowed CERELA to merge locally driven research with global immunobiotech expertise. The initiative fostered cross-sector collaboration, integrating scientists, policymakers, producers, and educators who navigated technical, industrial, and social challenges beyond their traditional roles. Children's preferences informed product design. As the program became provincial policy, the MSD took the lead and coordination of the program's expanding network. The Intersectoral Board as a co-production site fostered trust, learning, and joint problem-solving, leading to improvements in product design, delivery, and coordination. This collaboration between local actors enabled local adaptations, diversified products (Figure 3d), and expanded probiotic access to remote areas—

e.g., using dehydrated formats to overcome logistical challenges in hot, rural zones with poor infrastructure (Figure 3e)—advancing MSD's province-wide goals and strengthening regional industrial and technological capacities. Local agency, engagement and negotiated decision-making were key:

> "An intersectoral roundtable was set up. (…) *When I say ministries meet, I mean committed people from those ministries who build relationships and persuade others to move forward.* (…) Tucumán already had experience coordinating across sectors, (…) so we replicated that to address health and nutrition. Yogurt was the starting point…" (MSD official, 2013, interview)

> "We worked hard on training—teachers, principals, schools. (…) We had to explain what it was, how to implement it, and its effects. (…) *You have to give people a voice—to explain what we're doing, why, and what we expect.* (…) That's key. *You won't avoid criticism or resistance, but it helps reduce it*." (MSD official, 2013, interview)

Phase 5 (2011-2015). The *Yogurito* program showed results of improved child health, reduced absenteeism, and enhanced school performance (Villena *et al.*, 2012; 2018; González, 2020). For Tucumán's dairy farmers—hit hard by land concentration and 1990s neoliberal reforms—the program was a turning point. Farmers began organizing in 2006, creating the Tucumán Dairy Board and, later, the Trancas Basin Dairy Producers Association (APROLECHE) to meet *Yogurito's* demand. Backed by provincial purchasing power, they coordinated large-scale raw milk supply.

As *Yogurito* expanded, dairy farmers grew into and organized collective actor, shifting from raw milk suppliers to co-managers of production, gaining influence in the decision making process and adding value across the supply chain. This led to the creation of the Tucumán Dairy Technology Hub (2011), enabled dairy sector diversification, and the launch of the local brand *Ñulac* (2014). With support from CERELA and the state, the cluster secured funding to improve milk quality, preserve artisanal knowledge, and boost profitability via quality standards and circular whey reuse. Participation in international fairs aimed to reduce state dependency and promote a self-sustaining, formalized dairy sector, with APROLECHE increasingly shaping local agricultural policy.

Phase 6 (2008-2015). After *Yogurito* became Tucumán's social policy in 2008, and the emblem of national STI policy (Figure 3g), the National Ministry of Social Development decided to scale it nationally, relying on CERELA's expertise, local food policies, and dairy producer mobilization.

> "We presented it [to the national Minister of Social Development] and [banged the table]: '*I want this across the North-East and North-West*. It must *become state policy*. The Ministry will fund the rations—*this is a political decision above all*.'" (STI Ministry official, 2014, interview)

However, national decision making and expansion efforts were halted by local political disputes, leadership turnover, budget limits, and weak local production capacity, stalling *Yogurito*'s journey across other provinces. Despite political will and national STI steering coordination efforts (2008–2015) involving local governments, universities, and cooperatives faltered due to fragile territorial networks and persistent administrative hurdles. No replication achieved the scale or impact of Tucumán's original program (Figure 3f).

> "[Northern province] is in an *impasse*. Officials were enthusiastic, (…) but it stalled—new authorities came in and the project was left on standby." (STI Ministry official, 2013, interview)

> "There are periods that are sensitive and you need to seize them—like elections (…)—where public opinion matters, *and a product like this helps electorally*. But (…) if things don't move fast when there is an opportunity, *the network unravels*, and rebuilding it is hard. *There are always other priorities, urgent crises, and suddenly, funds disappear to deal with a flood or some emergency*. That's the reality of provincial budgets and management." (STI Ministry official, 2013, interview)

Phase 7 (2015-2024). Over the past decade, the *Yogurito* program stabilized, aligning its protocol with school food policies and holding annual planning meetings with Tucumán's MSD for the upcoming school year. Beneficiaries ranged from 200,000 to 300,000 children across 56 schools, with funding gradually shifting from national to solely provincial sources due to federal budget cuts. School distribution paused during the pandemic and resumed in 2022. As the project stabilized—an exception in Argentina's volatile political landscape—, and after the pandemic, the Intersectoral Board shifted to virtual coordination, maintaining ties between all stakeholders. Many original actors remained involved for years; while some have since retired or left public service, a core group still persists.

In 2020, French dairy multinational Danone expressed interest in the CRL 1505 strain, leading to a technology transfer agreement with CONICET (2022). CERELA conditioned the deal on including product donations to schools, preserving *Yogurito*'s social mission. Given CERELA's limited production capacity, the strain was licensed to and scaled up by the Italian ingredient firm Sacco for Danone's supply. The probiotic was incorporated into the *Yogurísimo* line in January 2023 (Figure 3h). Although a commercial product, CERELA views this as fulfilling the program's goals—addressing social needs, expanding access, and generating returns for the scientific system—while retaining technology governance, unlike the *Leche Bio* experience. Since 2024, amid drastic national budget cuts to science and welfare, *Yogurito* endures with provincial support, while CERELA sustains its work through technology royalties. *Ñulac*, created to boost local dairy production, faced economic hurdles, with its revival remaining uncertain. One of the lead scientists empha-

sizes how, in the final phase, diverse directions coexisted—and how CERELA played a key role in negotiating and preserving this balance through technology governance:

> "We were clear that *the backbone of this technology* transfer was—and remains—the Yogurito. Transfers (…) weren't conditional on suspending it; in fact, *we persuaded Danone*—though it's for commercial use of the strain—to also agree to donate a certain volume of yogurt (…). That social spirit behind the program gives us real satisfaction. The company accepted it, but had it not done so, we would've prioritized the program's original values." (*Yogurito*'s PI, interview, 2024)

> "Policy, timing, design, and scope changes *enabled us to sustain the social program while also allowing private use of the strain*—so it could reach broader society, which was always part of the goal. (…) Not everything must fall under social programs. *We all agree that developing the socio-economic fabric is key*—so *the private sector can work alongside the state, not in opposition*. We are public science, Argentine S&T, and *this technology can serve both state food policies and the private market*." (*Yogurito*'s PI, interview, 2024)

Figure 3. Location of Tucumán and main artifacts identified during Yogurito's.
Source: own elaboration. **(a)** Tucumán in Argentina; **(b)** *Leche Bio* at its 1995 commercial release (source: CERELA); **(c)** *Yogurito* as was launched in Tucumán, 2008; **(d)** New packaging and probiotic chocolate milk; **(e)** Biosec (lyophilized probiotic); **(f)** *Yogurito* in Misiones (*El Diario*, Córdoba); **(g)** *Yogurito* pavilion, Tecnópolis national expo, 2014; **(h)** Yogurísimo Cerela–Danone (CONICET). Unless otherwise noted, photos by Gabriela Bortz.

3.2. PARANÁ RIVER AQUARIUM

The Scientific, Technological, and Educational Center "Paraná River Aquarium", inaugurated in February 2018 in Rosario, Santa Fé, is the only freshwater aquarium in Latin America dedicated to native and established species of the Paraná River—one of the region's most biodiverse ecosystems (Figure 4). Initiated by researchers, it evolved into a strategic subnational project that combines biodiversity conservation, R&D, science education and interactive museum, and a hub for sustainable aquaculture services (Gázquez, 2024).

Phase 1 (2000-2007). In 2000, a fish biotechnology group was formed at the Institute of Molecular and Cellular Biology of Rosario under the National University of Rosario (IBR-UNR/CONICET). Initially focused on basic science, the group soon turned its interest to apply knowledge to river conservation and sustainable resource use. By 2003, driven by the need to secure live specimens, they partnered with Santa Fe's Ministry of Agriculture and the historic Rosario Hydrobiological Station (est. 1940), enabling controlled fish culture and supporting efforts to improve silverside aquaculture—a provincial priority.

Phase 2 (2007-2011). In 2007, the incoming socialist government elevated S&T to Secretary of State status (SECTeI), promoting collective project design and cross-sector collaboration (Bercovich and Bortz, 2024). As part of a participatory provincial Strategic Plan, the idea of a new *Paraná River Aquarium* on the site of the old Hydrobiological Station took shape. Close ties between the research team and SECTeI—rooted in shared academic and political backgrounds—fostered a joint vision of science as a collaborative, transparent, socially engaged public good.

> "We had an advantage (…) one of my team members (…) made things easier for us. (…) (He) is a socialist activist (…), we met when he was president of the Student Union, so he had a strong background in political leadership. He was key in convincing the government. (…) and making the Center idea seem viable" (Researcher, 2019, interview)

> "We already knew each other—I come from the university (…) and knew several key players in the system. So there was already a relationship in place. (…) Though I come from academia, my roots are in Socialist Party university activism. For us (…) everything is teamwork and collective effort (…). What you see at the aquarium is (…) a committed team that knows what they have to do (…)." (Government official, 2019, interview)

In a participatory Citizen Assembly, the Aquarium project was embraced into the Strategic Plan's "social quality" axis, promoting civic engagement. The project's scope, originally steered by the scientist, expanded to integrate human activity into conservation, restructuring it around three pillars: (a) scientific research, (b) fish production, and (c) education and recreation. To advance this vision, the research team and SECTeI submitted a co-developed proposal to the National R&D Agency, with SECTeI as partner. The agency rejected the initial broad conservation project and recommended narrowing the focus to fish-related R&D. A revised negotiated proposal centered on aquaculture, biotechnology, and genetic research was approved, specifically targeting fish conservation. By 2010, the Aquarium facility was upgraded, and the Aquatic Biotechnology Platform was launched on-site with the awarded grant.

In 2009, the provincial governor assigned the Aquarium's oversight to SECTel. A 2010 follow-up workshop, co-led with the research team, expanded the conservation agenda through dialogue with key Paraná River stakeholders—fishers, sport fishing groups, environmentalists, researchers, students, government agencies, solidarity economy groups, and national parks representatives, and general public.

Phase 3 (2011-2017). The 2011 provincial government shift, within the same political coalition, marked the consolidation of both fish biotechnology R&D and the start of aquarium's construction. In 2012, the Aquatic Platform secured an IDRC-funded project under the International Barcode of Life (iBOL) for sustainability research, enhancing its global visibility. The project advanced genetic barcoding for ecosystem monitoring, which required deep local knowledge of the Paraná River. The team partnered with the Espinillo Association of artisanal fishers—a vulnerable community, long-established in the area—whose extensive local knowledge, practical taxonomy and fishing expertise enriched the research. This collaboration also prompted outreach efforts by scientists and the Aquarium to support the fishers' livelihoods, while successfully advocating for the inclusion of dedicated river access in the facility's design.

> "We wanted to connect with the fishermen *because they know the river best*." (Researcher, 2019, interview)

> "Most of us fishermen used to think scientists looked down on us—that we were just (...) statistics. But they truly value the *empirical knowledge we have, the weight of years fishing and knowing the river*, and they *give it a meaningful place in their work*." (Fisherman, 2019, interview)

> "Once, while sampling, we caught a type of *tarucha* we thought was the common one. [The lead fisherman] pointed out morphological differences, and though we didn't see them at first, *genetic tests confirmed he was right*—it was a different species." (Researcher, 2019, interview)

With the launch of construction bidding, design decisions on the building and its grounds took shape around transparency and exchange: glazed labs, open views of the river, clear tanks showcasing murky native fish (Figure 4d). As the science coordinator put it: "(...) the first ones to step into the fishbowls were us the researchers" (2019, interview). The plan included new public walkways reclaiming previously closed riverfront with native plant areas (Figure 4b-4c-4g), acclimatization and fish care zones (Figure 4h), labs (Figure 4d), aquaculture pools to provide services (Figure 4e), a cafeteria, the aquarium (Figure 4h, 4i), and a fishermen's dock (Figure 4f), including their claims into the structural design.

> "(...) the transparency of the buildings reflects a concept—bringing people closer to research and vice versa. Those exchanged glances matter in construction. It wasn't just throught of as a building, but as the ideology behind it." (Researcher, 2019, interview)

> "For the first time, the local government took systematic action regarding fishermen (...)" (Cityhall worker, 2019, interview)

In 2015, the riverwalk opened (Figure 4c, 4g), and a scientist from the Aquatic Biotechnology Lab—active in socialist politics—was appointed as on-site director.

In the following years, designing the large tanks for coexisting freshwater species—an unprecedented task in the region—became a challenge. It required combining international expertise, fishermen's ecological knowledge, and the research team's ingenious workarounds (Bortz, 2025), leading to novel tank design skills. Organizing the Aquarium's structure also proved a complex task, which reflected negotiated priorities between the multiple involved stakeholders. Although the original plan included a fishermen's port, its construction was never completed (Figure 4f), exposing the unequal inclusion of artisanal fishing in the project and broader power asymmetries among public actors[4] (Roldan and Arelovich, 2020).

Phase 4 (2017-2019). In 2017, the research team relocated to the new site, and the *Paraná River Aquarium* opened to the public in 2018. This coincided with the consolidation of Santa Fé's STI policies, notably Law No. 13,742/2018, which boosted provincial funding for STI, mandated a 10-year strategic plan, and created the ASaCTeI, Santa Fé's STI agency, to ensure continuity and strengthen key initiatives (Bercovich and Bortz, 2024).

Within the productive axis, the Aquarium also operated between two contested systems. While artisanal fishing was participated—though subordinately—in space and knowledge-sharing, new insights into the Paraná River have yet to impact decision-making in either artisanal or industrial fishing. In contrast, the Aquarium advanced sustainable aquaculture—aligned with provincial priorities—through tools and services, a priority also reflected in the space assigned in the building's structure (Figure 4e). Another priority was the educational and recreational axis, which fostered river stewardship by engaging the public: research was translated into interactive exhibits (Figure 4i, 4j) and guided tours led by 18–30-year-old local residents showing the river's ecosystem and resources. This residency program, aimed to bridge between research and the public, encouraging participants to internalize the experience and even to launch their own outreach projects, such as studying river microplastics. Educational materials were co-developed by specialized staff and the resident team.

[4] This restricts artisanal fishing, while private clubs expand with little oversight despite irregularities.

> "That interaction, that *conversation with producers sparks development ideas*. (…) There are preliminary [biological] questions we need to answer (…) to then advance with development (…) These are paths to explore." (Researcher, 2023, interview)

> "The *inclusion of producers* (…) *is essential to keep our feet grounded*. But (…) *researchers* also have the *ability to look beyond* immediate concerns—even when they are not framed as demands. We are obliged to *look a little further*…" (Researcher, 2013, interview)

> "Science for whom, and for what? We cannot ignore *we're part of a society with needs*. (…) So we do science, but also try to *reach out to society and make a difference*." (Researcher, 2013, interview)

Phase 5 (2019-2023). After three Socialist administrations, Santa Fé elected a Justicialist Party government in 2019. Although the Ministry of STI was downgraded to a Secretariat under the Ministry of Production, the Provincial S&T Law held, and by 2022 the STI Strategic Plan and Council were established. The Aquarium governance came under the new STI Secretariat, now managed by the Innovation Projects Directorate. Without an on-site director, operations were impacted.

The COVID-19 pandemic (2020) exposed structural weaknesses at the newly opened Aquarium: contract lapses, payments were delayed, and key systems faced disruptions. Though a smaller team was rehired by 2021 for maintenance and education, staffing remained below 2019 levels, limiting programming and the guided tours that served as societal bridges (Gázquez, 2024). QR codes for self-led visits replaced in-person guidance, straying from the participatory, interactive education model co-developed with the community in 2010. Under the new management, a divide emerged between provincial authorities and the lab, as conservation goals gave way to tech-driven infrastructure and reduced educational staffing.

> "*Before*, the tour was *longer* and covered the whole park, upper floor, and a full lab explanation. *Now* it's *shorter*. The park is open, with some comments on what is there, and there's a brief overview of research at the hall entrance before heading upstairs. (…) *There are also self-guided visits now*—which I personally don't like. (…) *I don't think they serve the purpose the Center was created for*." (Researcher, 2023, interview)

Despite showing public support, the government offered limited backing, shifting the Aquarium's focus from conservation to innovation—a shift resisted by the lab. The research team upheld and expanded its conservation role, for instance, applying genetic expertise and collaborating with the local university on wetlands and fire-related biomonitoring. Meanwhile, authorities repositioned the Aquarium within a broader STI agenda—promoting startups, productivity, and Rosario's global biotech image. This included hosting a biotech startup on-site, or positioning the Aquarium as a gathering hub for the local biotech community.

In 2023, a new coalition led by the Radical Party—with socialists included—took office, naming former socialist science minister as STI Secretary. Despite a national STI funding crisis, the province resolved contract and maintenance issues. Still, amid a national budget cuts, funding for the Aquatic Biotechnology Lab remains uncertain, threatening the Aquarium's research and conservation stability.

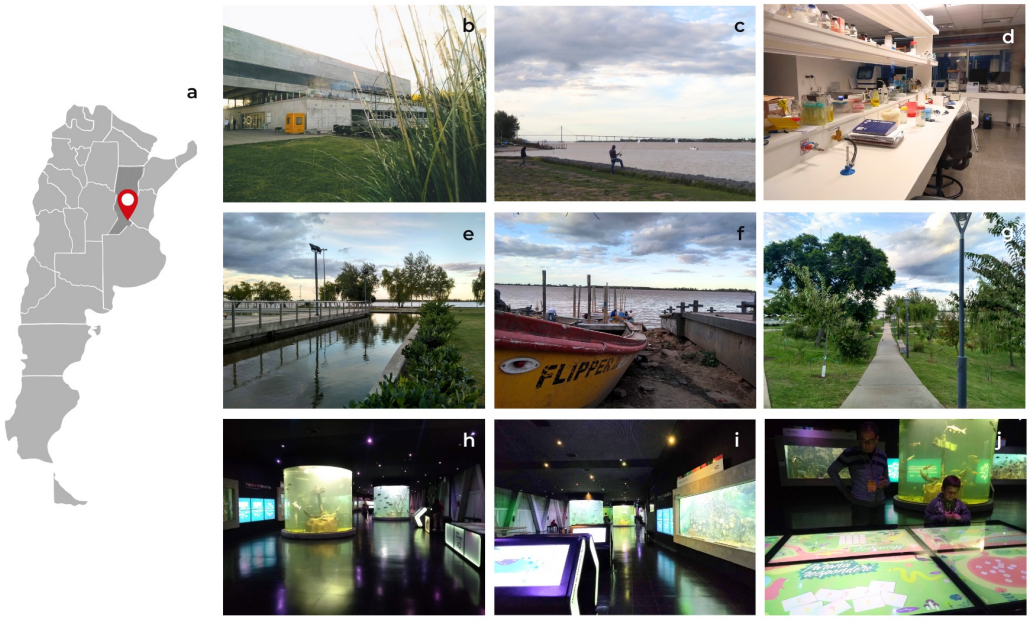

Figure 4. Location of Rosario and main features of the *Paraná River Aquarium*.
Source: own elaboration. **(a)** Location of Rosario in Argentina; **(b)** view of the Aquarium from the park; **(c)** public recovery of the riverside; **(d)** aquatic biotechnology laboratory; **(e)** aquaculture pools; **(f)** artisanal fishing port; **(g)** native species park; **(h)** main exhibition hall with fish tanks; **(i–j)** educational interactive devices. Photos by Gabriela Bortz.

4. NEGOTIATING POLICY AND INNOVATION ALTERNATIVES

Following Transformative Innovation Theory (Weber and Rohracher, 2012; Schot and Steinmueller, 2018), these cases could be read as niches that drive socio-technical change to tackle complex societal challenges. Notably, these initiatives arose organically from local needs, predating—but aligning with—later frameworks of transformative innovation and mission-oriented subnational policies. Key transformative elements include: (1) Directionality – initiatives are purpose-driven, aiming at social goals like access to basic goods, local development, territorial recovery, public space, biodiversity, and marginalized group support; (2) Inclusivity – diverse actors, especially marginalized groups, shape innovation through participatory methods, democratizing innovation; (3) Learning and Reflexivity – continuous adaptation and feedback guide responses to uncertainty, driving

further innovation; and (4) Systemic Impact – essential for sociotechnical change, evidenced by cross-sector and provincial coordination, embedding S&T in broader change processes. While all these aspects merit deeper analysis, this section centers on the challenge of analyzing negotiating directionality (and its governance) in the pursuit of social transformation[5].

Building on the framework in 2.2 and Figures 1–2, Figures 5–6 map shifting directionalities in the *Yogurito* and Aquarium journeys. Each chart functions as a radar, tracing how directionality evolved across different levels and orientations over their respective 40- and 20-year trajectories.

Figure 5 shows how initially focused on basic research (1), the lab pivoted in the 1980s to develop a functional food for malnutrition at a children's hospital's request. Though unsuccesfully intended for poverty alleviation (2), the first phase led to *Leche Bio*—a niche product controlled by two firms—driven by preferred infrastructures at the time such as IP, tech transfer infrastructures, and market logics (3) (Bortz *et al.*, 2018). In contrast, *Yogurito*'s second phase re-centered public health and poverty alleviation, distributing yogurt to schools and community kitchens (4). Backed by the Ministry of Social Development and local dairies, within a peak of social development policies, the project grew through co-creation (5), local adaptation and grounded policy mixes, and territorial networks, forming the Intersectoral Roundtable to coordinate stakeholders, co-produce knowledge, and link health goals with local recovery and science education. These dynamics made *Yogurito* a mission-oriented project, sustaining its transformative goals despite Argentina's unstable policy context (Arza and Brau, 2021). Phase 6—the attempted expansion to other provinces—showed the limits of scaling a technology fix for poverty alleviation without local co-creation (6), while Phase 7 saw successful tech transfer to Danone and Sacco, expanding markets while safeguarding *Yogurito*'s core values on territorial impact—thanks to CERELA's governance and the project's robust foundations (7).

[5] Other dimensions are explored in Bortz and Thomas (2017), Bortz, Gázquez and Santos (2022), Gázquez (2024).

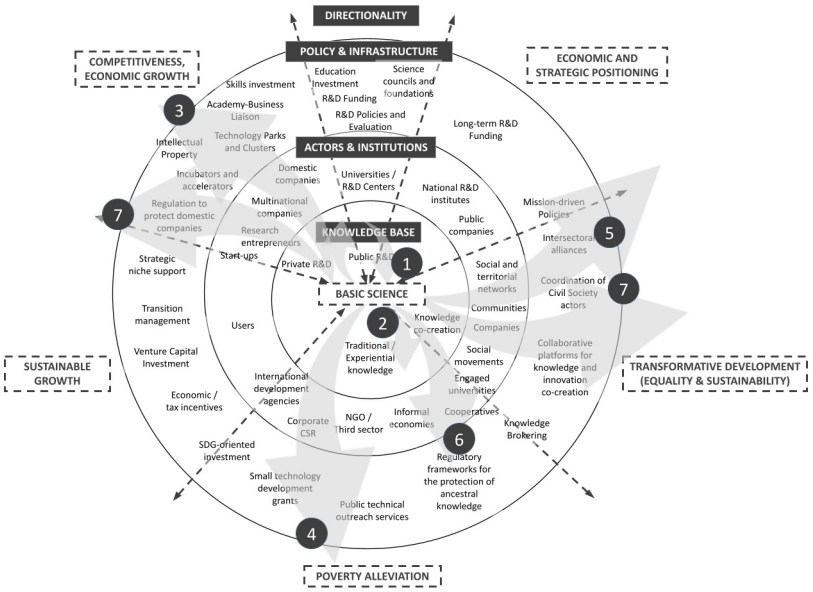

Figure 5. Negotiating directionality in *Yogurito*'s journey.
Own elaboration. Numbers reflect the shifting directionalities throughout *Yogurito*'s journey, as discussed in the text: **(1)** basic research, **(2)** poverty alleviation, **(3)** competitiveness, **(4)** poverty alleviation, **(5)** transformative development, mission-oriented policy, **(6)** poverty alleviation, **(7)** transformative development coexisting with competitive agendas.

Figure 6 traces the Aquarium's shift from a science-focused lab (1) to a mission-oriented, government-backed initiative aimed to sustainability. Early partnerships with local actors enabled species access and facility development, while informal networks across university, municipal, and provincial levels promoted river conservation and citizen engagement (2). Meanwhile, SDG-oriented international cooperation through iBOL broadened the knowledge base toward sustainability (2). Long before mission-oriented frameworks gained policy traction, the Aquarium functioned as a context-specific policy mix with sustained provincial funding—unusual in Argentina's volatile STI landscape (3). Its model combined global knowledge production with services for local producers, biodiversity preservation, environmental education, recovering public urban space, and public outreach (4). At one point, it included poverty reduction efforts via support to fishing families, though these waned due to limited network backing (4). In its later phase, the project aligned with national STI shifts favoring startups, venture capital and market-driven innovation (Cressman, 2019), drawing new actors and investment (5). While the government emphasized biotech visibility and competitiveness, the research team continued to uphold the original conservation mission (5).

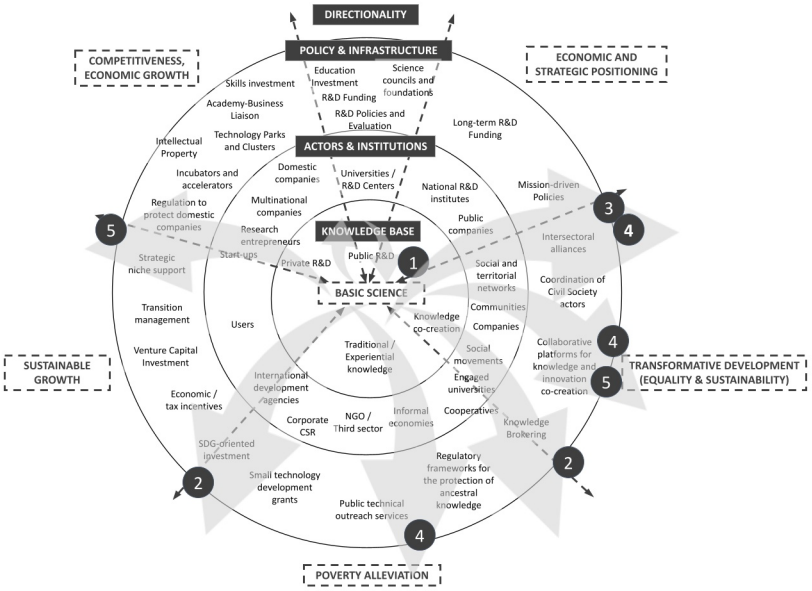

Figure 6. Negotiating directionality in the *Paraná River Aquarium* journey.
Own elaboration. Numbers indicate shifting directionalities in the Aquarium's journey: (1) basic science, (2) transformative development and sustainability, (3) strategic economic positioning, (4) strategic positioning with transformative and poverty-reduction goals, (5) transformative aims contested by competitiveness agenda.

Building on these cases, we highlight four points:

1. Rethinking directionality. In Transformative Innovation Theory, "goals" are concrete, measurable targets, while "directionality" refers to broader normative trajectories—such as sustainability or inclusion—that guide innovation toward systemic change. Though distinct, both are interlinked: goals may shift with context or new knowledge, while directionality acts as a compass, aligning innovation with long-term societal values (Smith *et al.*, 2005; Weber and Rohracher, 2012). This interplay allows initiatives to adapt while remaining anchored in a transformative purpose. However, our cases show the reverse: goals like aiding underserved children or conserving ecosystems remained stable, while directionality was renegotiated as future visions evolved. We therefore conceptualize directionality not as fixed, but as a dynamic, co-constructed process shaped by actors' visions, knowledge, and means—often reflecting diverse or conflicting orientations. Transformative directionality thus emerges through negotiation, expanded participation, and evolving notions of inclusion and sustainability.

Also, as "societal change" is often loosely defined, drawing on theory and empirical cases, Figures 1–2 and 5–6 help clarify what counts as transformation and to what extent. The lower triangles in the graphs represent transformation goals pursued through different pathways—revealing how directionality aligns with actors, chosen means and

framings. For instance, sustainability as decarbonization or inclusion via poverty alleviation contrasts with deeper aims of transformations of material, epistemic, political, and socioeconomic structures.

2. Agency and instrument selection. The cases underscore the central role of agency in shaping transformative change by negotiating future visions and the paths to reach them (van Lente, 2012). Even with shared goals, the directionality of change is co-shaped by actor networks, policy preferences, and selected instruments—highlighting the political economy of policy tools (Lascoumes and Le Galès, 2007), normative preferences embedded in policy design (Akrich, 1992), and the constructed functions of technology and policy (Bijker, 1995).

The cases—echoing studies such as Thomas *et al.*, (2017) and Bortz and Thomas (2017)—show that rigidly applied instruments designed or scientific advancement or competitiveness, often failed to enable transformative development. This misalignment between policy means and societal ends is especially clear in the *Leche Bio* outcome. In contrast, the most transformative outcomes emerged from flexible, context-specific policy mixes—combining citizen assemblies, participatory management, community engagement, science education, IP tools, tech transfer, services to third parties, and co-creation platforms.

These subnational, bottom-up mission-oriented policies predated recent STI frameworks, initially led by researchers and later adopted by governments through iterative negotiation, co-creation and grassroots legitimacy. Sustained by public funding, competitive R&D grants, and autonomous revenue, they ensured long-term viability and impact.

3. Territorial sensitivities. The cases illustrate how transformative goals, actors, and tools are deeply rooted in territorial dynamics—shaped by local ties, knowledge of social and productive realities, and political context. This grounding fostered broad local engagement, collective visions of change, and the development of relevant knowledge and technologies to pursue them. Though initially addressing specific local problems, both cases grew through engagement with wider networks drawn from the local fabric. They challenged dominant technoproductive models—e.g., dairy industry concentration vs. support for small producers, or extractive vs. artisanal fishing or sustainable aquaculture. Artisanal fishing was reexamined as both a livelihood and a neglected identity bounded to the river. Strong territorial anchoring, continuity of technical staff, and deep-rooted local legitimacy helped the initiatives persist despite shifting national politics. Both relied on collaborative efforts based on formal and informal participatory mechanisms—assemblies, roundtables, workshops, informal networks—that evolved into lasting consultative spaces. This broad alignment enabled durability, even across political divides.

4. Limits to transformation. While both cases stand out as promising STI policies for inclusion and sustainability—reviving neglected sectors, improving nutrition, restoring public space, and conserving ecosystems—they remained isolated niches. They did not reverse structural issues like poverty, systemic inequality, agribusiness concentration, or environmental degradation. Latin America's deep-rooted inequalities, fragmented and extractive economies, and underfunded STI systems compound the region's socio-economic and environmental challenges. These subnational missions demonstrate the value and potential of locally driven change as catalysts for transformation, but also expose their limits when not aligned with national policies and resources—restricting them to isolated interventions rather than systemic change. Though they move beyond "tech fixes," without broader cross-sectoral federal commitment, they risk remaining "sociotechnical fixes"—shifting sectors without transforming systemic regimes.

5. CONCLUSIONS

This paper examined how inclusive and environmentally focused research and innovation policies challenge dominant models by reshaping directionality and governance for social transformation. We contribute to Critical and Transformative Innovation Studies by addressing gaps around agency, continuity politics and territorial sensitivity bringing Latin American perspectives. Expanding a Knowledge Systems approach, we advocate for a broader, more symmetrical view of innovation that values diverse actors, policies, infra-structures, and knowledge—beyond competitiveness-driven assumptions.

Through case studies and literature review, we reframed directionality as both the negotiated process shaped by actors' conflicting visions, knowledge, and value-laden policy choices—and its evolving outcome, rather than a fixed endpoint. Tracing each case as an innovation journey, we suggest it is not the path of a vessel with a single captain but one where multiple actors contest the wheel, each seeking to steer through shifting waters. This lens highlights how innovation is steered, toward which goals, and why some directions prevail over others.

The cases show that while specific inclusion or sustainability goals may persist, directions and outcomes shift as power dynamics evolve and new actors reshape policy preferences—often reframing these contested concepts in turn (Gallie, 1956) in broader or narrower terms. Our grounded empirical research aimed to specify these evolving interpretations, showing how they are shaped by the paths taken.

A key insight is the role of the political economy of policy instruments, which embed future visions and co-shape directionality. Instruments designed for growth or competitiveness often fall short of transformative goals, underscoring the need for context-sensitive policy mixes. Territorial actors and networks were essential to expanding these initiatives from tech fixes to sustained, multi-actor interventions involving policy, organizational, and technological experimentation. Yet, while these substate mission-oriented policies offer opportunities for meaningful sociotechnical change, their transformative success depends on cross-sector federal political commitment. Without this, and sound advocacy to push this agenda forward beyond STI realms, they remain "sociotechnical fixes," impactful, capable of localized change but insufficient to shift systemic regimes.

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Translating Transformative Innovation Framework in Colombia

Governance Implications for STI Policy

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ABSTRACT

This article analyzes the transfer process of the transformative innovation policy (TIP) framework in Colombia and the translation process carried out by Science, Technology, and Innovation (STI) policy actors, emphasizing the implications of this process for governance. Using the Colombian Green Book 2030 case study and its regional implementation, the article examines how the TIP framework has been adopted by stakeholders and reinterpreted in peripheral contexts. A qualitative study with an interpretive approach was conducted based on 30 semi-structured interviews with individuals involved in the analyzed transfer process, as well as observations and document reviews. The findings suggest that institutional inertia has influenced the appropriation of the TIP framework in Colombia, leading to its association with prior social innovation experiences that align with some of the framework's characteristics. This includes participation and the inclusion of local actors. The framework was reinterpreted to address specific local issues through niche configurations rather than destabilizing socio-technical regimes. This frames transformative change within policy instruments designed under a bottom-up model. Nevertheless, the territorial level has emerged as a key space for TIP experimentation, offering opportunities to explore other STI applications oriented toward social concerns. The study concludes that transferring the transformative framework provides an opportunity to reconsider STI policy governance.

Keywords: Transformative Innovation; Governance; Policy Transfer; Regional Approach; Colombia.

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INTRODUCTION

Science, Technology, and Innovation (STI) policy frameworks are the product of a simultaneous configuration between theory and practice (Smits *et al.*, 2010). Therefore, it is relevant to understand how conceptual models are translated into the design and implementation of policy instruments (Stone, 2012), as well as how these circulate in different social and institutional contexts (Peck, 2011). The study by Schot and Steinmueller (2018) proposes the emergence of a Transformative Innovation Policy (TIP) framework as an alternative to the dominant frameworks, namely, the linear and interactive innovation policy frameworks. The conception of innovation as a sequential process of activities over time is present in the linear model, while a systemic view of innovation highlights the interactions and relationships between actors and institutions (Godin, 2017). The interactive framework is associated with the concept of national innovation systems, oriented towards competitiveness (Chaminade *et al.*, 2018).

Multilateral organizations have played a relevant role in the diffusion of these dominant STI policy frameworks (e.g., OECD, UNESCO, OAS), influencing the design, implementation, and evaluation of policy instruments (Diercks, 2018; Nupia, 2013; Velho, 2011). Historically, the Science Policy Research Unit (SPRU) at the University of Sussex has participated in the creation and diffusion of innovation models. For example, the creation of the demand-pull model from the SAPPHO project (Godin, 2017) and the diffusion of STI policy instruments in developing countries through the STPI project (Sagasti, 1978) also transferred to the Colombian context (Nupia, 2013).

However, the limitations of these frameworks in addressing global crises such as climate change, inequality, and other problems manifested locally have motivated the emergence of alternative framework approaches (Table 1). In the last decade, a third generation of STI policy frameworks has gained space in the research agenda, characterized by its orientation towards solving social and environmental issues (Haddad *et al.*, 2022). Among these, the TIP framework stands out, which proposes the deliberate transformation of socio-technical systems through processes of experimentation, collective learning, and broad actor participation (Schot & Steinmueller, 2018). This framework was developed by researchers associated with SPRU articulated around five central principles: directionality, societal goals, systemic-level impact, learning and reflexivity, conflict management, and inclusiveness (Boni *et al.*, 2025).

Colombia constitutes an emblematic case of TIP framework transfer in Latin America. Since 2016, the country has actively participated in the Transformative Innovation Policy Consortium (TIPC), an initiative led by SPRU with agencies from Norway, Sweden, Finland, and South Africa. This participation responded to a long tradition of transferring science policy frameworks in the country, dating back to the STPI project in the 1970s (Nupia, 2013). As a result of this linkage, in 2018 the National Science and Innovation Policy for Sustainable Development (Green Book 2030) was published, a set of normative statements that sought to align Colombian STI policy with the sustainable development goals (SDGs) through the TIP framework (Colciencias, 2018).

The TIP framework transfer process in Colombia included explicit efforts for dissemination at the subnational level. During the construction of the Green Book 2030, the document *Guidelines for the Formulation of Regional Transformative Innovation Policies in Colombia* was developed (Colciencias & SPRU, 2018). This policy orientation aimed to disseminate the framework based on regional experiences identified in collaboration with academics who actively participated in the Departmental Councils of Science, Technology, and Innovation (CODECTI). These are an institution of subnational governance of the country's STI policy. This experience created a reference for the dissemination of the TIP framework for system actors, particularly in territorial levels characterized by high levels of poverty and historical exclusion from scientific and technological development.

This case of TIP framework transfer in Colombia is the unit of analysis of this research, in which we aim to answer the following questions: why was the transformative innovation framework transferred to STI policy in Colombia during the period 2016-2018? How did STI policy actors in Colombia translate the transformative framework in the Colombian context? What were the implications of this transfer for the governance of STI policy in that country?

Although previous studies on the TIP framework in Colombia exist (Ordóñez-Matamoros *et al.*, 2021; Pinzón-Camargo *et al.*, 2023), they associate *a priori* the characteristics of this framework with the national policy of social appropriation of science, technology, and innovation (SASTI), implemented since 2005, based on an inclusive innovation model (Daza-Caicedo & Lozano-Borda, 2013). Our study, on the contrary, seeks to empirically reconstruct the transfer process of the TIP framework through a qualitative case study of an interpretative type, based on 30 semi-structured interviews with key actors who participated in the formulation of the Green Book 2030 and its regional implementation. This is complemented by participant observation and documentary analysis. This analysis reveals that the translation of the TIP framework in Colombia was deeply influ-

enced by prior social innovation (SInn) experiences and by the need to respond to specific local problems. This re-signification led to emphasizing dimensions of the framework related to bottom-up participation and the protection of local niches, while central elements such as the destabilization of socio-technical regimes and the coordination of instruments for systemic transformations were neglected.

The article is structured into five sections. First, we present our analytical framework, integrating literature about emerging STI policy frameworks and policy transfer. Second, we describe our research methodology. Third, we empirically analyze the transfer process of the TIP framework in Colombia and the characteristics of its circulation in that context. Fourth, we discuss the implications of our findings for STI governance. Finally, we present conclusions that highlight the theoretical and policy contributions of our research.

1. THE TRANSFER OF EMERGING STI POLICY FRAMEWORKS IN PERIPHERAL COUNTRIES

We propose that the reconstruction of the TIP framework transfer process in the Colombian context is influenced by the dominant vision of science and its perceptions in local contexts (Velho, 2011). In that sense, we consider necessary to explore those STI policy frameworks that have positioned themselves as alternatives to a dominant vision oriented towards economic competitiveness (Schot & Steinmueller, 2018). This is a starting point to understand the transfer and adaptation process of the TIP framework in peripheral contexts. The proposed analytical framework is based on the intersection of three major themes in the study of STI policy: emerging policy frameworks, the transfer of these policies, and the peripheral context in which they are put into practice. With this, we seek to explore the movement, contextualization, and reinterpretation of models by actors embedded in a particular context (Peck, 2011).

In that sense, our analytical framework is based on the following assumptions:

1. The emergence of alternative innovation policy frameworks to the dominant ones is influenced by normative reorientations rather than by alternative STI policy models, in which a systemic vision of the innovation process dominates.

2. One of these emerging frameworks related to transition studies is transformative innovation, which proposes changing socio-technical systems through different interactions between three levels (landscape, regimes, and niches).

3. The transfer of policy frameworks in Latin America is a recurring behavior in the configuration of state institutions. In the Colombian case, the TIP framework is transferred and interpreted by actors as a reference for bottom-up STI policy actions through the formation or protection of niches in local contexts.

4. The transfer of the TIP framework in peripheral contexts through these interpretations has implications for STI policy governance, insofar as it limits the design of policy instruments that transcend the protection of local niches.

1.1. EMERGING POLICY FRAMEWORKS AND TRANSFORMATIVE INNOVATION

Emerging innovation policy frameworks are characterized by presenting alternatives to dominant visions focused on actor interaction for competitiveness (Schot & Steinmueller, 2018). Among these, the TIP framework, Mission-Oriented Policies (MOP), SInn, and Social Technology (ST) are representative. Table 1 presents a comparison of these emerging frameworks, exploring their similarities and differences through variables such as normative objectives, innovation model (Godin, 2017), central actors, governance structures, and policy instruments (Diercks, 2018).

Although the normative objectives share the purpose of providing alternatives to dominant frameworks, they present significant differences. The TIP framework and MOP focus on grand societal challenges as articulators of innovation policy; among these climate change, poverty, and inequality (Haddad *et al.*, 2022). Meanwhile, SInn and ST focus on problems presented by society that are not resolved by the capitalist system, although each in its own way: SInn seeks to solve problems without profit motives, while ST focuses on the solidarity economy through technologies that liberate society from the control of dominant institutions (Dagnino, 2014; Galego & Brans, 2023).

Regarding the innovation model, it is possible to observe that there is no alternative proposal to a systemic vision of innovation policy. The systemic perspective refers to the relationships between institutions and organizations (Godin, 2017). For example, transformative innovation emphasizes changing socio-technical systems, that is, the set of artifacts, infrastructures, practices, and social relations that structure the generation and use of technologies (Kanger & Schot, 2019). The idea of connecting actors to solve social or environmental problems is present in the other policy frameworks, although in Latin American practice, many SInn initiatives have reflected a continuation of the linear innovation framework (Mercado *et al.*, 2014).

A broadening of the actors considered within the innovation process is observed, compared to those traditionally institutionalized (government, university, and business). TIP is based on the participation of the actors that assemble the socio-technical system itself in order to modify the dominant rules and regimes (Haddad *et al.*, 2022; Kanger *et al.*, 2022). MOP involves multiple actors in the definition of missions and solutions while highlighting the role of the private sector (Mowery *et al.*, 2010). Both SInn and ST normatively defend innovations oriented towards solving social problems, but ST makes a more radical reinterpretation of the links between STI and economic production. In the ST frame, local actors build new forms of autonomous economic integration in the face of peripheral capitalism (Pozzebon *et al.*, 2023). This multiplicity of actors reflects a recognition of other forms of knowledge production not exclusive to academia (Gibbons *et al.*, 1994).

Governance structures, that is, the ways in which social actors (state, firms, civil society) solve collective problems (Kuhlmann *et al.*, 2019), are linked to the normative objectives of each framework. TIP highlights the role of institutional intermediaries for the coordination of experimentation and proposes formative evaluation as an instrument to generate learnings during experimentation (Molas-Gallart *et al.*, 2021). MOP focuses on the coordination of different public policy instruments linked to a portfolio of projects (Haddad *et al.*, 2022). Both SInn and ST emphasize forms of collaborative governance, although ST adds a strong component of community self-management and local empowerment in the control of technologies.

From the TIPC perspective, the TIP framework is articulated around five central characteristics: directionality towards societal goals, systemic impact, learning and reflexivity, conflict management, and inclusion of marginalized actors (Boni *et al.*, 2025). These characteristics are applied in experimentation processes in protected spaces where other forms of governance and collective visions of the future are structured (Engels *et al.*, 2019). In this context, interactions between the levels of the socio-technical system can generate four types of changes: i) technological substitution, resulting from a consolidated disruptive innovation; ii) transformation, induced by exogenous pressures that motivate incumbent actors to adjust the regime; iii) reconfiguration, where niches are integrated into the regime for mutual benefit; and iv) de-alignment and re-alignment, which occur when exogenous actors destabilize the regime to rebuild it around an emerging niche (Sovacool & Hess, 2017).

The Latin American and Caribbean Transformative Innovation Hub (HUBLAyCTIP) has operationalized the TIP framework in evaluations of experiments in agrifood systems in Chile, Colombia, and Mexico. These cases show initiatives that concentrate on building

niches that drive initial learnings and linkage of actors excluded from the dominant socio-technical regime. Examples include the construction of an agroecological niche for the lime production chain in Oaxaca (Mexico) that combined knowledge from indigenous communities with social economy (Bueno *et al.*, 2023); agroecological practices for cocoa production in Valle del Cauca (Colombia) through transformative networks among small producers, but without linkage to actors of the regional extractivist model (Osorio-García *et al.*, 2023); and making visible local practices of family farmers for water use and conservation in Chile as a response to the large-scale agricultural model (Albis *et al.*, 2023).

These analyses reveal a characteristic that has become generalized in peripheral contexts: the niche is understood mainly as a space of resistance for marginalized actors, without necessarily representing a broader regime change. This tendency contrasts with the original vision of the TIP framework and represents a conceptual challenge for transformative public action, specifically regarding the design of instruments that allow transcending the local scale towards systemic transformations.

Table 1. Emerging STI Policy Frameworks.

	Transformative Innovation Policy (TIP)	Mission-Oriented Policies (MOP)	Social innovation (SInn)	Social technology (ST)
Normative objectives	Transform socio-technical systems to address grand societal challenges through building directionality that modifies rules and regimes.	Articulating missions to mobilize actors for the development of multiple technologies or innovations that contribute to addressing the grand societal challenge.	STI are oriented to solving social problems and not for generating profits.	Make self-managed ventures economically viable. Technologies must be liberating and not subject to the control of capitalist techno-science.
Innovation Model	Systemic/Interactive. Multi-level perspective (niches, regime, landscape). Experimentation and transformation through incumbent actors or reconfiguration of regimes.	Systemic/Interactive. R&D for grand challenges. Top-down societal objective and bottom-up solutions.	Systemic/Interactive. Bottom-up. Social actors interact to find a collective solution to the problem.	Systemic/Interactive. Reorientation of the profit generation system appropriated by companies towards social/local problems.
Actors	State; Third Sector; Social organizations; Social movements; Firms; Universities.	State; Third Sector; Firms; Universities/R&D institutions.	State; Third Sector; Social movements; Firms; Universities.	State; Third Sector; Local Communities; Social movements; SMEs; Universities.
Governance Structures and Policy Instruments	Institutional intermediaries. Formative evaluation. Building a theory of change (ToC).	Policy mix (sectors). Portfolio of instruments. Centralized coordination and decentralization of R&D activities.	Collaborative governance Social actors develop actions and activities to respond to a social problem according to constraints and opportunities.	Self-empowerment and community management of technologies. Public policies based on social participation.

Source: Own elaboration based on (Diercks *et al.*, 2019; Doezema *et al.*, 2019; Galego & Brans, 2023; Haddad *et al.*, 2022; Mowery *et al.*, 2010).

1.2. THE TRANSFER OF INNOVATION POLICY FRAMEWORKS

The construction and diffusion of innovation policy models (i.e., linear innovation) are social processes that result from the interactions between various actors, who are typically bound to academic spheres. These actors advocate for the implementation of these models in the private and public sectors (Godin, 2017). In that sense, the diffusion of theoretical frameworks into policy models and instruments has been studied from two perspectives: i) policy transfer and ii) policy mobility.

Policy transfer is an area of political science that, under a positivist approach, seeks to explain how agents of a political system make the decision about the selection of a model (whether these are represented in objectives or ideas, institutions, or regulatory mechanisms) and put it into practice (Stone, 2012). Regarding innovation policies, international organizations and actors often play a role in the diffusion of models generally based on the dominant notion of science (Velho, 2011). Although in the Latin American case the transferred frameworks are not necessarily fully coherent with the formulation of plans or programs; these processes open windows of opportunity for new power relations among actors (Feld, 2014). In Colombia, the transfer and adaptation of the linear innovation framework directed the design of policy instruments from the 1960s (e.g., STPI Project, 1973) (Nupia, 2013). Mostly, policy model transfers are based on selecting the "best practices" that are socially valued as a success or a failure based on their results (Peck, 2011).

Meanwhile, policy mobility proposes a more constructivist approach in which models are studied as a process resulting from the interconnection of actors and continuous mutation, considering the context and valuing the construction of agents' capacities in the framework's circulation process (Peck, 2011). Thus, policies circulate in physical spaces (i.e., a territorial scale) or in cognitive spaces, such as networks between academics and public officials, where policies are assembled based on the local context. These physical and cognitive spaces can be constructed from a technocratic approach, that is, privileging linear direction from academia to society, or from a participatory approach where actors are considered in the construction of the model (Ramirez *et al.*, 2024).

Within this, the process of *translation* of concepts into policy instruments becomes relevant insofar as actors give new meanings to the concepts of a framework based on the context, which modifies both the framework and the institutional context in which it is put into practice (Doezema *et al.*, 2019). For example, the TIP framework translated by innovation policy actors in Sweden was based on prior experiences of mission-oriented policies in a context of institutional inertia such as bureaucratization and a parliamentary

political system that tends towards stability (Ulmanen *et al.*, 2022). In that sense, it becomes relevant to reconstruct how actors put the TIP framework into practice in the Colombian context; for example, a prior exploratory study showed that a translation associated with a smaller territorial scale can limit socio-technical transformations due to low innovation capacities in these territories (Garzón & da Costa, 2021).

2. METHODOLOGY: AN INTERPRETATIVE CASE STUDY OF THE TRANSFER PROCESS

This study adopts a qualitative case study design with an interpretative approach, apropriate for reconstructing social processes from the experience of the involved actors (Summer & Tribe, 2008), which for our purposes refers to the TIP framework transfer process in the Colombian context. Thus, a variety of methods were employed to gather information about the subject of the study, which were subject to triangulation: i) 30 semi-structured interviews with actors (government and university representatives) who took part in the development of the Green Book 2030 and its regional approach through transformative innovation mentorships (Table 2), conducted between 2019 and 2024; ii) participant observation records resulting from one of the researchers' involvement in Minciencias between 2020 and 2022; iii) documentary analysis (reports, minutes, presentations), and casual discussions with academics involved in the first phase of the transfer.

Data analysis was carried out through a process of coding and categorization, that is, the assignment of codes or labels to statements from an interviewed actor as a mechanism for reconstructing the meanings given by them. Categorization is an interpretative exercise that links the theoretical framework with the empirical results (Saldaña, 2016). For the analysis of qualitative data, a mixed inductive and deductive strategy was used. That is, the codes used for data analysis were proposed based on the literature on the TIP framework (deductive), being complemented by the interpretative process based on the data itself (inductive) (Summer & Tribe, 2008).

Table 2. Actors in the TIP framework transfer interviewed.

Type of Actor	Affiliated Organizations	Interviewee ID
Government representative	Minciencias, Misión de Sabios, Ruta N, CGR, DNP, OCyT Agrosavia	A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S.
University representative	ITM, PUJ, Unal, UNAB, Unibagué, Uniandes, URosario, Univalle, Universidad Eafit, Usalle	T, U, V, W, X, Y, Z, AA, AB, AC, AD, AE, AF, AG.

Source: Own elaboration.

3. THE TRANSFER OF THE TRANSFORMATIVE INNOVATION POLICY FRAMEWORK IN COLOMBIA: THE TRANSFER PROCESS IN ITS BEGINNINGS

3.1. COOPERATION AGREEMENT: MECHANISM FOR TRANSFERRING THE TRANSFORMATIVE FRAMEWORK

In the 2010s, STI policy in Colombia went through a process of institutional change characterized by a regionalization of public investment in R&D and innovation, funded with 10% of the royalties from hydrocarbon exploitation (Orozco *et al.*, 2019). This influenced the multilevel governance where regional governments acquired decision-making power in resource allocation (Interviewee G), while at the national level (Colciencias), territorial problems were addressed through inclusive innovation programs (e.g., *Ideas para el Cambio* in Spanish) (Interviewee C). Considerig these changes, demands for strengthening Colciencias' administrative capacities were addressed, among other actions. This occurred by the signing of a cooperation agreement with SPRU to improve the policy design and evaluation capacities of an internal working group created for that purpose (Congreso de Colombia, 2016).

As part of this agreement, in April 2016 researchers from SPRU and Ingenio at Universitat Politècnica de València (UPV) conducted a training program on STI policy evaluation, based on "frame 3" (TIP). This training disseminated a rationality focused on social problems and the use of participatory methods (SPRU & Ingenio, 2016a). In a second training conducted in November of the same year, this approach was implemented in pilot evaluation projects of STI programs developed by Colciencias (*Empresa Altamente Innovadoras, Alianzas por la innovación, Colombia Científica*, in Spanish) (SPRU & Ingenio, 2016b). However, initial questioning of the TIP framework by national government officials of these programs led to rethinking the agreement's strategy towards actors at the regional level; this was through *mentorships* that aimed to disseminate the notions of the transformative framework to university actors linked to the CODECTI, which were considered a more participatory and inclusive governance instance (Interviewees C, X, AA, AD).

3.2. TIP FRAMEWORK MOBILITY: TRANSLATION AND RE-SIGNIFICATIONS THROUGH THE CONVERGENCE OF EMERGING FRAMEWORKS

During 2017, the cooperation focused on the regional level, a more flexible space to experiment with policy instruments outside traditional visions (Interviewees X, AA). In that sense, representatives from universities and other CODECTI members were initially brought together to disseminate ideas of the framework that represented more of an

expectation and not consolidated policy models (Interviewee X). In these spaces, the idea emerged to conduct regional mentorships for the identification of experiences that were already being implemented at the regional level beyond traditional policy frameworks (Interviewees C, X, AA, AD). Table 3 classifies these experiences according to the regional context in which they were developed, that is, large urban centers or rural regions. Although each experience is diverse in its context and local problems, as a result of the analysis, we found in common a translation of the TIP framework. Its rationality is justified by placing empowered society at the center of STI policy.

Table 3. Transformative Innovation Mentorships (2017).

Regional classification	Mentorship	Region
Large urban centers	Institutionalization of the TIP Framework in governance instances	Cali, Valle del Cauca
	Digital Labs "Vive Lab"	Bogotá
	Evaluation based on TIP Framework	Medellín, Antioquia
	Co-creation of regional STI policies	Medellín Antioquia
	Changes in food production and consumption as a transformative niche	Barranquilla, Atlántico
Dispersed settlement	Creativity labs in rural schools	Tolima
	Coffee agro-chain within peace agreement	Cauca

Source: Own elaboration based on Colciencias and SPRU (2018).

Society at the center of policy has several meanings according to the interviewed actors. On one hand, it represents the citizens who directly or indirectly benefit from policy action (Interviewees A, E). On the other hand, the vision of empowered citizens, traditionally neglected by STI policy, is more recurrent (Interviewees N, X, Y, AG); although prior SInn experiences where these actors have been institutionalized (i.e., organized communities, social movements, cooperatives) became a reference for the translation of the TIP framework (Interviewees A, AB, AC, AD, AE). In each mentorship, this implied that the TIP framework was applicable when using design or evaluation instruments from a *bottom-up model*, which guaranteed broad actor participation and referred to problems posed by them (Interviewees H, AG, Q, R, AA). In this way, a discourse of the TIP framework as a model for experimenting with social organizations was constructed, which became institutionalized in the imagination of Colciencias officials some time later on (Interviewees F, M).

3.3. IMPLICATIONS OF THE TRANSFER FOR STI POLICY GOVERNANCE IN COLOMBIA

We found that the translation of the TIP framework in its beginnings had a normative implication, insofar as it was oriented towards an approach typical of SInn. According to the institutional tradition of STI policy, it had been implemented in regional contexts (Interviewees X, Y, AA, AG). The actors who participated in the mentorships re-defined the focus of this policy framework in Colombia as one that, by transcending traditional visions of innovation (supply-side or for competitiveness), enables a variety of actors (e.g., ethnic communities, peasants, students) to participate in SInn programs or in regional STI policy governance instances (Interviewees A, F, N, O, S, X, AG). Once translated, this transfer mechanism of the framework laid an interpretative base influencing STI policy governance in Colombia until recently.

This transfer process coincided with the creation of the Ministry of STI (2017-2019) which was based on the Second Misión de Sabios. The TIP framework was regarded as relevant for bringing STI policy to peripheral regions characterized by high levels of poverty (Interviewees Q,R). In fact, the National STI Policy 2022-2031 (CONPES, 4069) contemplates an experimentation program to promote STI projects with a transformative focus, which at a strategic level contributes to a more inclusive appropriation policy (CONPES, 2022). Likewise, the organizational structure of the Ministry of STI was designed under two vice-ministries (knowledge, innovation, and productivity) focused on instruments to promote research and business productivity, and on the other hand, (talent and appropriation), which focused on social appropriation policy with an inclusive focus.

SASTI thus became, at the institutional level, the form of translation and implementation of the TIP framework, specifically, through a deeper linkage of its programs with TIPC (Interviewees K, X, AB, AG). For instance, the program *A Ciencia Cierta* was the object of experimentation using the methodology developed by that consortium (ToC) (TIPC, 2021), partly due to a greater willingness from the officials of that program to be engaged with the framework (Interviewee X). In this regard, we found that this normative-level association hindered a broader integration of other policy instruments, restricting TIP based actions to the construction and protection of niches.

Parallel to this transfer process directly supported by TIPC, within Colciencias a policy experiment was configured aimed at creating a Prototype STI Program to contribute to the implementation of the Peace Agreement (2016) in the Sierra de La Macarena. Armed conflict has historically affected this region. This prototype represented the Colombian government's first attempt to implement the TIP framework, given the peace-

building challenge posed by the Peace Agreement (Interviewees A, B, C). Implemented between 2017 and 2022, the prototype was structured to build solutions from STI to solve problems of drinking water, energy, and agricultural production in the region by the co-creation between universities and local social organizations (Interviewees A, B, U, V, W). Although this experiment was based on prior SInn experiences, it attempted to build governance by linking other STI policy actions, as well as other government agencies at different levels (national, departmental, municipal), as well as international organizations (Interviewees A, B, D, E). This generated institutional learnings about new uses and meanings of the TIP framework in the Colombian context, reinforcing a bottom-up model of STI policy (Interviewee F).

4. DISCUSSION

The purpose of this study was to understand why the transformative innovation framework was transferred to STI policy in Colombia during the period 2016-2018. We found that the emergence of this framework in the European academic sphere coincided with a process of strengthening Colciencias' administrative capacities for policy design and evaluation. In that sense, a cooperation agreement with SPRU became the mechanism for transferring the TIP framework, which reflected a long tradition of transferring policy frameworks in Colombia's STI institutions (Nupia, 2013). Furthermore, we sought to understand how, in this process, STI policy actors in Colombia translated the TIP framework, evidencing a reinterpretation based on SInn experiences. This led to configuring the normative objective of the framework in the Colombian context for bottom-up actions, which solved problems at the territorial level. In that sense, governance is associatiate to this framework for policy actions with local communities, limiting the purpose of policies with the construction of niches and shielding (Kanger *et al.*, 2025).

Studies on the transfer of the TIP framework point to the importance of institutional traditions in the process of translation and legitimization (Ulmanen *et al.*, 2022). In the Colombian case, it meant the participation of academic and government actors with a track record in developing programs closer to the SInn framework, such as the SASTI policy. Thus, the mobility of the TIP framework in that context represented the positioning of emerging frameworks that had already been operationalized according to the needs indicated by the actors (Peck, 2011). It was not an effort to fit into the model defended by SPRU. This tendency is common in peripheral countries that operationalize emerging STI policy frameworks, such as responsible innovation (Doezema *et al.*, 2019). This seems

even more recurrent in the transfer of these emerging frameworks, when there is still no consensus regarding what transformative change means and how it is put into practice (Kattel *et al.*, 2025).

The theoretical implications of these results are oriented towards thinking about the convergence of emerging policy frameworks in peripheral countries, whose legitimacy depends on the consideration of the problems present in that context. We found in our study that actors who participate in the translation of novel frameworks appropriate elements from other coherent approaches, such as SInn or ST, to interpret and put TIP into practice. This is comehow contraditory with the European vision of the TIP framework, which aims for large coordinated interventions between sectors and policy instruments as a basis for the destabilization of socio-technical regimes (Haddad *et al.*, 2022); this type of governance is operationalized by multilateral organizations that actively recommend linkage with business development instruments (OECD, 2024). In this regard, it is necessary to consider whether the transfer of this framework to the Colombian context constitutes a window of opportunity to bring to the forefront issues and actors that have remained relegated within the country's STI policy. Specifically, it is relevant to establish the type of socio-technical change that should be normatively desirable in peripheral contexts, namely, reconfigurations of regimes around emerging niches or transformation of the system through exogenous pressures (Sovacool & Hess, 2017).

Limitations of this study are related to the focus given to the initial phase of the transfer process, as well as a profile of information sources from traditional actors such as universities and government representatives. Despite this, actions were implemented to guarantee triangulation of the collected information. In addition, the initial phase of the framework adoption process (2016-2018) was prioritized to understand the initial phase of the studied process, as well as the experiences and meanings given by the actors. This can influence the study of recent cases of transformative innovation in the Latin American context. Therefore, this study opens a path for the analysis of operationalization experiences of the transformative framework. According to the interviewees, the prototype STI program implemented in the context of the Peace Agreement is a relevant case that can shed light on a more recent phase of TIP framework mobility in the Colombian context.

CONCLUSIONS

The transfer of the TIP framework in Colombia from the Green Book 2030 was influenced by the country's prior SInn experiences, as well as the emergence of local problems and the positioning of other actors (such as social organizations). These actors had prior experience working with traditional STI policy actors, such as universities. Thus, the normative objectives of the TIP framework were reinterpreted by the actors as a form of experimentation with other possible governance models of STI policy, but not necessarily overcoming the dominant systemic vision of innovation. Based on the interviewees, it is highlighted that the implementation of this framework in the Colombian context presents different challenges in governance terms. Mostly, overcoming the vision of the TIP framework as a reference for SInn to align with internal Colciencias policy instruments, as well as other sectors and levels of government.

Faced with institutional inertia in the cooperation agreement regarding business development policy instruments, the participating actors translated the territorial level as the scenario for experimenting with this emerging framework. Especially because it was considered the space of an empowered and participatory civil society that could guide transformations. The presence of an active society understood as an advantage for the deployment of the TIP framework has a contradiction with the low institutional capacities at the local level, coupled with a dependence on resources from the central government. This is interpreted as a barrier during the experimentation process. This initial experience of the TIP framework transfer process in Colombia shows that it is not a linear process of using theories in policy but rather involves consideration of the capacities of local actors, as well as their positioning in the political arena. That is, power relations as an articulating element that guarantees long-term experimentation.

The main implications of these results are aimed at rethinking the process of transfer and circulation of emerging STI policy frameworks in the Colombian context. Insofar, as the translation by local actors tends to present different frameworks in which normative elements or models converge according to the problems presented, institutional traditions, or the prior experiences of the actors themselves. In that sense, for the Colombian case, this implied in governance terms an assimilation of the TIP framework as a reference for the experimentation of co-creation processes with communities at the territorial level. This hindered the linkage with other policy instruments capable of influencing changes at the socio-technical regime level. This questions the need for the TIP framework in the Colombian context, insofar as other emerging frameworks offer conceptual references for inclusive-type innovations.

The study of policy instruments designed and implemented from the beginning, based on the TIP framework, remains a research gap, additional studies may illuminate the understanding of how emerging policy frameworks are operationalized in peripheral country contexts. For example, our study identified that the prototype STI program for the implementation of the peace agreement in Colombia can show empirical evidence of the transfer and mobility process of this framework for specific contexts. We argue that, although prior SInn policies that defend bottom-up actions are relevant for the translation of emerging frameworks, it is necessary to transcend the niche level to orient socio-technical changes.

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Grassroots Innovation Ecosystems

Alternative Agri-Food Networks (AAFNs) in Brazil and Turkey

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ABSTRACT

This paper theorises how inclusive grassroots innovation responds to socio-economic inequalities and facilitates efforts to overcome them, contingent on solidaristic relationships. As a mainstream policy concept, the term 'innovation' has become more narrowly defined as capital-intensive technological innovation, which has often worsened social inequalities. In response, 'inclusive innovation' has become an umbrella term encompassing diverse alternatives seeking to reduce or avoid social inequalities. These have arisen especially in the Social Solidarity Economy (SSE), based on democratic self-management and mutual aid; its enterprises depend on wider ecosystems of support groups. The SSE has some overlaps with Alternative Agri-Food Networks (AAFNs), which build greater social proximity between producers and consumers. Hence the overlap is here called the SSE-AAFNs. During the Covid-19 pandemic, many SSE-AAFNs rapidly adapted to the disruptions through novel practices that could fulfil their members' needs. SSE-AAFNs ecosystems played this creative role through three general parameters: inclusive grassroots innovation, agile adaptations, and a transformative resilience bouncing forwards. These parameters form a tripartite framework that helps to analyse case studies of SSE-AAFNs in Brazil and Turkey. In both cases, grassroots innovation helped to overcome social inequalities (of class, race, gender), in ways contingent on each initiative and its context. SSE-AAFNs have demanded and gained support measures from municipalities, along lines helping to build collective capacities rather than dependence. The tripartite analytical framework here has wider relevance to SSE ecosystems developing grassroots innovation which can overcome inequalities.

Keywords: Alternative Agri-Food Networks (AAFNs); Inequalities; Social Solidarity Economy (SSE) Ecosystems; Inclusive Grassroots Innovation; Agile Adaptation; Transformative Resilience.

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INTRODUCTION

As a mainstream policy concept and academic area, the term 'innovation' has become narrowly defined as capital-intensive technological innovation, driven by research and development (R&D). This top-down innovation model has a long history of worsening social inequalities. Consequently, it has failed to address basic needs of lower-income people.

Such inequalities have stimulated demands for socially just alternatives. 'Inclusive innovation' has become an umbrella term, encompassing diverse alternatives. These have drivers especially in the Social Solidarity Economy (SSE), based on democratic self-management. This has some overlaps with Alternative Agri-Food Networks (AAFNs), which build greater social pro-ximity between producers and consumers. We give their overlap a hybrid name, SSE-AAFNs, as the research focus here.

This paper theorises how inclusive grassroots innovation responds to socio-economic inequalities and facilitates efforts to overcome them, contingent on solidaristic relationships. It explores the following questions: How do social inequalities (of class, race, gender) motivate involvement in SSE-AAFNs? How do their practitioners attempt to overcome inequalities, especially through inclusive innovation? What are the roles of wider support networks and care relationships? Under what conditions does inclusive innovation facilitate efforts to overcome inequalities? Given the societal benefits from SSE-AAFN, under what conditions can these be best developed and expanded? What are the main barriers?

To address these questions, we draw on a literature review and two empirical case studies: Brazil and Turkey. Our overall argument can be summarised as follows: SSE support networks can be understood as multi-actor ecosystems, which help generate alternative forms of economy. SSE-AAFNs mobilise inclusive grassroots innovation through collective capabilities, including agile adaptations and a transformative resilience. Through such collective capabilities, as manifest especially during the Covid-19 pandemic, SSE-AAFNs have helped to overcome or avoid social inequalities.

The paper is structured as follows: Section 1 surveys critical literature on the dominant innovation versus inclusive innovation. Section 2 theorises the SSE as innovation ecosystems through a tripartite framework: grassroots innovation, agile adaptation and a transformational resilience. Section 3 surveys AAFNs literature, especially as regards social inequalities and innovation. Section 4 briefly explains the methods used in this research. Sections 5 and 6 present our two empirical cases, Brazil and Turkey, respectively, empha-

sising how SSE-AAFNs responded to the Covid-19 crisis and how they continued some gains afterwards. Section 7 returns to the original research questions, giving answers with broader relevance than the specific case study.

1. CONTESTED INNOVATION STIMULATING ALTERNATIVES

Innovation has always existed in the broad sense of applying novel methods to daily practices. Yet over the past century the term 'innovation' has become more narrowly defined as capital-intensive, R&D driven and top-down. In contrast, inclusive innovation has been devised as an alternative, even as resistance. This section outlines hegemonic versus alternative forms of innovation.

According to Benoit Godin, in the 1950s innovation became an object of imagination, linked with economic growth for common societal benefits:

> On one side, people started producing thoughts on what innovation is, how it happens, and with what effects. Economic growth—"growthmanship" as some called it—supported by public policy, gave the concept of technological innovation a social existence. On the other side, policymakers started inventing policies and strategies to support innovation, thus legitimising the emerging discourse (Godin, 2020, p. 2)

Godin analyses the contradictory relationship between research and commercialisation at the heart of technological development: Although originating from the same conceptual framework (growthmanship), research and innovation are opposite values' (*ibid.*, p. 7).

As he emphasises, technological innovations have been generally accompanied by social innovations, especially various privileges and patent laws rewarding novelty. By the late 20th century, innovation was well understood as commercialisation of scientific knowledge (Godin, 2008, 2015). In practice, technological innovation has been dependent on institutional change, deriving from socio-economic innovations. But this relationship is obscured by the prevalent top-down model. Oppressive power relations become reified as inherent properties of technological innovation, promoting a technological determinist explanation of societal change (Godin, 2020). Socio-economic changes are seen as 'impacts' or (at most) as favourable contexts for a quasi-inevitable technological advance.

Consequently, the top-down research and development (R&D) systems underpinning mainstream technological innovation have failed to address the basic needs of lower-income people (Papaioannou, 2018; Levidow & Papaioannou, 2017; Chataway *et al.*,

2013; Smith *et al.*, 2014; Arocena and Sutz, 2012; Srinivas & Sutz, 2008; Cozzens, 2007; Cozzens *et al.*, 2002; Prahalad, 2005; Arocena & Sutz, 2003). Technological innovation often worsens socio-economic inequity, e.g., by eliminating, transferring and/or deskilling employment. For example, the manufacturing sector has traditionally lost jobs due to innovative production technologies that required phasing roles and new skills (Cozzens *et al.*, 2002). When driven by R&D, technological innovation worsens disparities of wealth, control and privilege, benefiting some groups more than others (Wetmore, 2007). In fact, technological innovation has brought wealth, social respect, cultural prominence and further political voice for those already powerful, while excluding the interests and aspirations of the many (Acemoglu & Johnson, 2023). It may continue to do so in the 21st century through artificial intelligence (AI), machine learning (ML) and other automation technologies. In such a context, any societal benefits have often excluded lower-income and marginalised people.

Therefore, overcoming social inequality and exclusion has motivated redesigning innovation. As a general alternative, inclusive innovation is a process that 'harnesses science, technology, and innovation "know-how" to address the needs of lower-income groups' (OECD, 2012, p. 9). Bottom-up solutions are necessary for 'the inclusion of those left behind in the race to the top' (Leach & Scoones, 2006, p. 66). The 'inclusive innovation' research agenda has focused on bottom-up alternatives to top-down innovations. These are: bottom-of-the-pyramid products which are cheaper functional substitutes aimed at low-income populations (Prahalad, 2005; UNCTAD, 2014). Examples include: India's low-cost motorcar; Jaipur prosthetic foot; low-cost nets protecting people from mosquitos and thus malaria; cheap analogues of patented drugs or treatments.

In those ways, the hegemonic innovation model has stimulated popular resistance and alternative economic forms. As key drivers, 'The alternative pathways have emerged in the interstices of a world in which people see their communities, democratic institutions, jobs, material culture, and personal relationships being uprooted by distant economic and political institutions that seem unresponsive to their needs', argues David Hess (2007, p. 15). But alternative pathways often lose their original driver and aim; they either become marginalised or else are absorbed into the mainstream economy. To avoid those outcomes, it is necessary to localise political activism, innovation and economic activity in political alliances (*ibid.*).

Such solidaristic alternatives generally have arisen from grassroots innovation movements. They 'involve a base of local actors and therefore different forms of knowledge, including community-based and indigenous knowledge and the knowledge of the

lay public in the process of innovation' (Smith *et al.*, 2016). Such movements use their ideas, knowledge and capabilities to create their own innovative alternatives as well as to challenge political structures which produce socio-economic inequality (Smith *et al.*, 2017).

As a relatively new framing, transformative innovation aims to reduce inequality in all its forms, 'but does not necessarily replace existing framings' (Schot & Steinmuller, 2018, p. 1554). Indeed, it encounters tensions. Any transformative trajectory undergoes conflicts with the hegemonic regime, thus either contesting or accommodating it (Fressoli *et al.*, 2014). Amidst such tensions, SSE ecosystems can generate inclusive grassroots innovation, helping to maintain livelihoods and liberatory aims.

More specifically, grassroots innovation networks design processes that serve different needs and aspirations (e.g. Smith *et al.*, 2014, Fressoli *et al.*, 2014) e.g. India's Honey-Bee Network promoting local knowledge, innovations, biodiversity conservation, etc.; Fab Labs and Hackerspaces; Brazil's Social Technologies Network (RTS) providing solutions for social inclusion and improvement of livelihoods (Papaioannou, 2018). These solutions are both technical and political. Through grassroots innovation people use their ideas, knowledge and capabilities to create their own innovative alternatives as well as to challenge political structures which produce unjustified socio-economic inequality (Smith *et al.*, 2017). This paper takes forward such alternatives by identifying sources of grassroots innovation in the Social Solidarity Economy (SSE). The latter has devised means to include lower-income people in providing bottom-up solutions.

2. SSE INNOVATION OVERCOMING INEQUALITIES: TRIPARTITE ANALYTICAL FRAMEWORK

First, let us see how the Social Solidarity Economy (SSE) understands and addresses social inequality. Globally the SSE promotes 'a comprehensive approach based on an equitable distribution of wealth and universal access to the commons' (RIPESS, 2011, p. 3). 'The solidarity economy focuses on the empowerment of women and other marginalized groups, as well as the fight for social inclusion and against poverty' (RIPESS, 2015). SSE networks promote democratic self-management through cooperative, solidaristic, creative relationships.

The SSE aims to transform the current mode of production and exploitative division of labour, re-organising the relationship between public and private. SSE ecosystems' ethics, values and guiding principles prioritise their members and local communities

above profit, and embrace autonomous management, a democratic decision-making process and the primacy of people and work over capital (Amin, 2013, Kawano, 2013, Coraggio, 2014). SSE enterprises are major economic players in the sense that they increase productivity in some formal and informal sectors (e.g., textiles, agriculture, and recycling) and create sufficient employment (Chaves et.al., 2013). In creating jobs, the SSE enables young and marginalised people to be included in communities.

In recent years, the SSE has been understood as an 'ecosystem': SSE ecosystems are constructed and sustained by solidaristic interdependent actors; they encompass cooperatives or social enterprises, their networks, and their supporting institutions, e.g., civil society groups, banks, policy advocacy organisations, etc. enterprises and support networks (OECD, 2020, 2023). Through their various innovations, SSE ecosystems overcame many new challenges in the disruptive, uncertain context of the Covid-19 crisis, while also protecting their members' health and livelihoods (UN, 2021; ILO, 2020; Mohit, 2021). Advocates rightly attribute these achievements to solidaristic relationships, but the inclusive innovation processes and the internal dynamic capabilities which drive them remain obscure and undertheorized.

In parallel, relevant to the entire economy, an innovation ecosystem has been defined as an evolutionary structure where multiple actors and institutions interact in order to learn from each other, adapt to a rapidly changing external environment and survive. According to Yuen Ng *et al.*, (2023, p. 1), 'A key characteristic of an innovation ecosystem is that its members are loosely coupled and sectorally-spatially varied. Despite this nature, ecosystem members often coalesce into a cooperative community by revolving around the innovation at hand'.

By combining those concepts and insights, here we characterise SSE ecosystems as enabling to overcome or avoid inequalities. This role can be theorized through our tripartite analytical framework, linking three key parameters: inclusive grassroots innovation, agile adaptation, and a transformative resilience. Let us examine each parameter in turn.

2.1. INCLUSIVE GRASSROOTS INNOVATION

Over the last two decades, 'inclusive innovation' has become a crucial reference for alternative innovation that delivers bottom-up solutions to problems of lower-income people. As such, inclusive innovation integrates public-action initiatives, public policy agendas and specific innovations. This concept denotes low-cost innovations which serve such interests and aspirations. It fulfils basic human needs in sustainable ways, enhances human

capabilities, improves social welfare, potentially empowering lower-income and/or marginalised people and avoiding or overcoming social inequalities (e.g., Kaplinsky *et al.*, 2009; Chataway et al, 2014; Papaioannou, 2018; Smith *et al.*, 2014).

The 'inclusive innovation' research agenda has focused on such alternatives to top-down innovations (e.g. Smith *et al.*, 2014, Fressoli *et al.*, 2014). As Smith *et al.*, (2017) point out, inclusive grassroots innovation alternatives are motivated by explicit desire for economic and political change, committed to normative values of social justice and environmental sustainability. Indeed, theorists such as Papaioannou (2018), Onsongo and Schot (2017), Cozzens & Sutz (2014) and Eubanks (2007) have clarified the relation between ethico-political normativity and incentives for innovative change.

Global problems of inequality and social exclusion have been drivers for redesigning innovation to meet basic needs of low-income communities. Inclusive innovation 'is of increasing interest as nations look to use innovations to bring about more inclusive and equitable development' (Foster & Heeks, 2014, p. 2). Reducing inequality in generating and diffusing novel goods and services has become an imperative for inclusive innovation and development, according to several global bodies (UNDP, 2016; World Bank, 2010).

As a more specific term, *grassroots* inclusive innovation describes SSE actors in low-income communities creating public goods that help overcome social inequalities (Cozzens & Sutz, 2014, p. 13). Through capabilities for sharing, endorsing and developing alternative models, they have developed more equitable participation and collective agency in co-creating innovation. These networks have been theorised as grassroots innovation movements (Smith *et al.*, 2014) or innovation in informal economies (Cozzens & Sutz, 2014). In such ways, inclusive innovation in SSEs pertains to both substantive and process aspects of greater equality. Through participatory processes, marginalized communities become active agents in setting priorities and developing innovations fulfilling their basic needs to overcome inequalities (cf, Boström, 2012). Inclusive grassroots innovation 'underlined by counter-hegemonic values already exists, albeit in the cracks of the dominant system and in constant danger of co-optation', and so needs supportive policies (Robra *et al.*, 2023, p. 1). In Portugal, public funds have played a crucial role for social innovation projects of local associations (Ferreiro *et al.*, 2023).

Some AAFNs share such aims. They frame their actions as fulfilling the basic needs of food access; they enable non-exploitative agroecological production and build rural-urban connections. On this basis, low-income urban dwellers can access affordable quality food. Here inclusive innovation can be manifested in the diverse agricultural pro-

duction processes which are environmentally sustainable; traditional methods are often mixed with new scientific knowledge to maintain crop genetic resources and enable production in harsh environmental conditions without chemical inputs.

For example, some farmers in Italy have re-appropriated genetically diverse wheat. They have cooperated with several actors including scientists, processors, civil society and consumers, each playing diverse roles in the wheat value-chain. These innovations have been crucial in the steps towards transforming the agri-food system towards greater inequality (Rossi *et al.*, 2019). Inclusive innovation has generally helped overcome power asymmetries through non-hierarchical, solidaristic ties between small scale farmers, urban food coops and other actors of the SSE ecosystem; together this has empowered both producers and consumers (Rossi *et al.*, 2019; Alberio & Morelli, 2021).

In those various ways and contexts, agroecological producers develop skills to use environmentally sustainable methods; innovations combine traditional and scientific knowledge. A triple process of innovation—cognitive, technological, and sociopolitical—is encompassed in the same transformation. Social movements have achieved technological improvements through knowledge-dialogue (Toledo, 2012).

2.2. AGILE ADAPTATIONS: SOLIDARISTIC BASIS

The second conceptual parameter of our tripartite framework is that of agility. In the mainstream business literature, agility generally denotes an adaptive ability to rapidly exploit opportunities for gaining competitive advantage, especially in response to social change (Li & Holsapple, 2018). This implies organisations with higher levels of strategic, operational and leadership agility have a distinct competitive advantage (Albayraktaroglu, 2023; Joiner, 2019; Baškarada & Koronios, 2018). Here 'agility' generally denotes rapid responses to new commercial contexts, as if they were purely external.

For actors within SSE ecosystems, by contrast, agility can mean rapidly reconnecting internal and external solidaristic relationships. It can also mean new arrangements which bypass or minimise exposure to conventional market competition. Finally, it can mean conscientizing consumers about more socially just, environmentally sustainable production arrangements as the basis for novel products.

Much documentation has shown rapid adaptive responses to the Covid-19 pandemic. In the sectors of cleaning, food production, pharmacy, and software, cooperatives continued work by extending their services to non-cooperative members. Software cooperatives developed online platforms to help schools to sell and buy services and

essential products (Ciriec, 2020). In Cuba, SSE textile organisations started to manufacture PPE, food and cleaning organisations and went beyond their member base to help elderly and homeless people(Arencibia, 2021; Betancourt and Arencibia, 2023).

Inclusive innovation (especially its sub-category of grassroots innovation) is often a time-consuming, lengthy process. By contrast, agility is a fast, responsive process. SSE organisations' agility lies in their ability to create opportunities through rapid collective action.

Both innovation and agility relate to dynamic capabilities which enable mainstream enterprises organisations to address deep uncertainty, e.g. from rapid technological change or financial disruption (Teece *et al.*, 2016). In SSE ecosystems, solidaristic bonds facilitated rapid flexible adaptation, as manifest in the Covid-19 crisis (Zollet *et al.*, 2021; Atalan-Helicke & Abiral, 2021).

2.3. TRANSFORMATIVE RESILIENCE: BOUNCING FORWARDS

The concept of agile adaptation can be complemented by transformative resilience. In its familiar conventional sense, resilience denotes capacities to withstand stress or disruption through adaptation. The English term has a Latin origin: *resilare* as a leap backwards, meaning a bounce-back to a previous state. This meaning became more prominent when the Covid-19 pandemic declined; commentators expressed approval that agri-food systems had sufficient resilience, i.e. the ability to 'bounce back' from a drastic change (e.g. Worstell, 2020).

By contrast with the mainstream version, SSE organizations can develop a transformative resilience from both their internal and external solidaristic relationships. Emphasising the latter, the RIPESS 2021-2023 Strategic Plan identifies several pathways to promote global linkages among SSE organizations, support groups and knowledge-exchange about such efforts. Specifically, it proposes ways for them to develop more alliances with other transformative initiatives (RIPESS, 2021). This practical agenda provides more participatory opportunities for research to investigate and illuminate external relationships which underlie their resilient capacities.

During the Covid-19 pandemic, more than 1.6 billion workers in the informal economy have been affected by 'lockdown' measures and by working in the most affected sectors (UNRISD, 2020). SSE ecosystems responded by promoting cooperation and basic services in a different way, and by creating innovative forms of employment through diverse and complementary models of production. These practices have been documented by the ILO (2022) and the USAID-funded Cooperative Development Programme

(Tango International, 2020). Some studies have focused on how SSE organisations have responded to the Covid-19 pandemic, especially in the global South (Francesconi *et al.*, 2021; Tango International, 2020). SSE organizations themselves have exchanged such knowledge informally through local, national and global networks, especially the Réseau intercontinental de promotion de l'économie sociale solidaire (RIPESS, 2021).

Those solidaristic responses can be understood as resiliently 'bouncing forwards' through a collective choice of transformative change. Originating in disaster management, this concept describes a community's capacity to 'adapt in order to survive by changing its non-essential attributes and rebuilding itself' (Manyena *et al.*, 2011, p. 3). The concept 'bouncing forwards' can describe many SSE agendas.

In many AAFNs, rapid innovative adaptations jointly benefited commercialization by small-scale farmers during Covid 19, e.g. through virtual farmers' markets (Mittal & Grimm 2020; Thilmany *et al.*, 2021). Such flexible rapid responses come from adaptive capabilities of cooperative arrangements, especially 'their self-help values, democracy, and solidarity', as well as a 'member-centred mission' (Billiet *et al.*, 2021, p. 105).

3. AAFNS OVERCOMING SOCIAL INEQUALITIES?

Having discussed those three parameters of SSE ecosystems, let us now move on to the agri-food sector. As widely documented, the dominant agri-industrial system has caused various harms such as: imposing social exclusion, inclusion into exploitative relationships, environmental degradation, resource burdens and pollution, while marginalising more sustainable agri-food systems. It has extended the long-time capitalist transformation of agriculture. Since that process began with land enclosures, small-scale peasants have been further dispossessed and driven off the land by more subtle but systemic means, e.g., state subsidies cheapening exports, farm and retail concentration driving down farm-gate prices, supermarket chains marginalising farmers' direct sales, etc. (Friedmann, 1993; McMichael, 2005).

Since the 1990s such changes have been globally neoliberalizing the agri-food sector. This agenda has reduced the state's role through privatization, deregulation and other measures prioritizing global markets to pursue economic growth. The techno-optimist neoliberal framework has privileged techno-innovation as central means to address social and environmental problems (Robert *et al.*, 2025, p. 926). In practice, technological innovations have not helped conserve natural resources, nor enhanced

livelihoods for most farmers; for instance, 'smart farming' can and does worsen social inequalities by displacing farmers (*ibid.*). Indeed, capital-intensive technology has been a key factor in consolidating larger firms, to the detriment of small-scale producers (Clapp & Purugganan, 2020, p. 1267).

To resist the dominant system, Alternative Agri-Food Networks (AAFNs) have sought more equitable, sustainable pathways from producers to distributors and consumers. Some AAFNs seek to prefigure deeper societal changes in the food system, expressed through concepts such as relocalizing, respatializing, resocializing and reconnecting food-system actors (Renting *et al.*, 2003). Generally known as short supply chains, these have offered products at lower prices than specialist shops and supermarkets; they bring economic efficiency, technical innovation and greater social participation (Lamine *et al.*, 2018). AAFNs build farming methods different than large-scale agri-businesses by establishing shorter social distances between producers and consumers through novel food purchasing arrangements, e.g., cooperatives, farmers' markets, community supported agriculture-CSA, etc. (Jarosz, 2008).

Some AAFNs emphasise 'quality' characteristics encompassing social and environmental benefits beyond simply consumer enjoyment. For 'quality' food and wine products, innovations often have come from outsiders to the sector, thus originally autonomous. 'The innovations were successful enough to rapidly spread at the local level, building on a renewed vision of food quality and on a vision of technical and economic autonomy' (Darrot *et al.*, 2014, p. 149). The innovation relies on constituting independent, self-sufficient AAFNs, i.e. independent of the dominant techno-market regime; such an alternative can fulfil local demand whilst ensuring reasonable income to the actors (production, processing and marketing) involved in the niche (*ibid.*, p. 153).

As an early hopeful description, AAFNs are 'rooted in particular places, [and] aim to be economically viable for farmers and consumers, use ecologically sound production and distribution practices, and enhance social inequality and democracy for all members of the community' (Feenstra, 2002, p. 2; Renting *et al.*, 2003, p. 2). Such gains towards social equality were often presumed but were rarely investigated (Allen, 1991). Early studies rarely addressed unequal relationships such as power, income, domination and oppression in the production process, nor wider access to quality food through AAFNs (Goodman, 2004, p. 7).

AAFNs minimally aim to enhance producers' income, based on product quality and reputation. AAFNs are driven by interpersonal ties, trust, and reciprocity: economic relations are socially embedded. Like grassroots innovations more generally, successful

ones 'become embedded in wider society through different dynamics: expansion, reframing, circulation of knowledge, shifting material arrangements and replication' (Roysen *et al.*, 2024, p. 8). Yet this basis does not inherently avoid or overcome unequal social relations of power, domination, oppression, hierarchies, conflict, and personal gain (Maye & Kirwan, 2010, p. 4, 8).

By contrast, solidaristic AAFNs also seek means to overcome socio-economic inequalities, both for producers and consumers. Their socially transformative potential lay in wider initiatives such as transition towns, solidarity districts, group purchasing, etc., according to some advocates (Renting *et al.*, 2012). In such ways, many AAFNs have further developed characteristics of the SSE. Solidaristic frameworks seek to de-commodify food through inclusive innovation processes, such as ensuring fair prices for primary producers, lowering prices for disadvantaged groups, improving access to good nutritional food, and fostering diverse forms of production.

As potential means forwards, AAFNs create new models that engage public concerns about community, social justice, health issues such as nutrition and food safety, and environmental sustainability. AAFNs differ from conventional agri-industrial networks as regards their organisational structures, farming systems, territorial setting, food supply chains, policy support, and food 'quality', which may include social, cultural, ethical, economic and environmental benefits. All those aspects may be closely inter-related (Karner, 2010, p. 9). For many participants of AAFNs, localisation expresses 'trust and cooperation between the actors who are working together to create a more sustainable food system', likewise decentralised governance models, encouraging local democracy, recognition, participation and empowerment, while countering the power of the globalised food system (*ibid.*, p. 10, 41).

In urban contexts, solidaristic AAFNs sometimes combine all those aims. In Manchester the various drivers encompass poverty, unequal access to goods and services, social exclusion, and health inequalities; together these have prompted the emergence of interlinked AAFNs (Psarikidou & Szerszynski, 2012, p. 34). They manifest 'social cooperation, solidarity, and trust'. More profoundly, 'relations of solidarity and justice with proximate and distant others, regard for land and for the global environment, social inclusion, the well-being of the disadvantaged, and the reskilling of everyday life' (Psarikidou & Szerszynski, 2012, p. 36). These novel interlinkages can be understood as grassroots inclusive innovation.

As one solidaristic form, community-supported agriculture (CSA) schemes, have sought to overcome material barriers such as land access and poor nutritional habits. In Wales some CSAs found ways to gain land access from private landlords and the local university (Mert-Cakal & Miele, 2021). To overcome nutritional inequalities, potential improvement include food-related social issues, requires supportive policies for sustainable eating, i.e. 'dedicated support policies for a plurality of components' (Giovannini, 2024, p. 931).

An unusual form of AAFN, agroecology-oriented food redistribution coalitions arose in Spain to address the rising levels of food insecurity during the Covid-19 pandemic. The coalitions represent a convergence of diverse social struggles, centring intersectionally marginalized groups, e.g. migrant, racialized women working as caregivers and the *pueblo gitano* (e.g. Romany). Tensions arose around needing to balance the goal of providing access to healthy and sustainable food with the affordability of such produce. In those initiatives the predominance of women reflected our society's unequal division of food-related care work. Mutual-aid groups collectivized such work of three kinds: food procurement and distribution, food preparation in community kitchens; and food-related knowledge exchange, e.g. through recipes. Moreover, the coalitions territorialized alliances between actors from urban and rural settings and between urban centres and peripheries. Together these efforts enabled participants to transform gender relations. But efforts to overcome wider subaltern roles faced many obstacles (Facchini *et al.*, 2024).

4. RESEARCH MATERIALS AND METHODS

Alongside the broad literature review in earlier sections, this paper draws on data from research projects in Brazil and Turkey, especially during the Covid-19 pandemic. Methodologically, both cases had multiple information sources. Through more Internet searches, those data have been extended and re-interpreted for the new analytical framework, which post-dates the original research projects. In both countries, the academic team structured a knowledge co-production process with SSE-AAFNs, supported by wider SSE ecosystems. Together this material provides a basis to compare the two cases (as in Yin, 2018); see Table 1.

The first project focused on the agroecology-based solidarity economy in Brazil, especially short supply chains, there called circuitos cortos (AgroEcos, 2022). The qualitative methodology was a knowledge-exchange among initiatives and with the research team. Beforehand, the team first reviewed the literature on three themes: the EcoSol-

agroecology convergence in Latin America, Participatory Action Research (PAR), and means of recording the research process.

The Brazil research plan included workshop methods to engage local actors. However, in early 2020 the Covid-19 restrictions precluded this plan. As a different way forward, local solidarity networks were adapting to the Covid-19 pandemic, expanding their activities, publicising their *circuitos curtos*, connecting more groups, appealing for practical support, etc. They were using social media such as Facebook and holding webinars as a multi-stakeholder knowledge exchange. So, the project was able to strengthen, publicise and record those efforts; it also did online interviews. The empirical material on specific initiatives has been published elsewhere (e.g. Levidow *et al.*, 2022a, 2022b, 2023). Rather than repeat such details, this paper updates the secondary sources for a national overview, alongside a specific initiative from a student thesis (Silva, 2022, 2023).

The second research project focused on Turkey's solidaristic networks of agri-food cooperatives. It gained both primary and secondary data. It initially analysed available secondary sources (e.g. archival data and organisational documents, coop web pages, press reports, bulletins and social media resources). Afterwards, open-ended, in-depth interviews were conducted between 2021 and 2022 with founders, members, volunteers, and producers/consumers of two food coops: one being a consumer and the other a producer coop: namely, Vakıfköy Women's Enterprise Production and Management Coop (Vakıflı women's coop) and Bogazici Members Consumer Coop (BÜKOOP). The project analysed how both cooperatives responded to the challenges of the pandemic (Öz & Aksoy, 2024). The two Turkish co-authors were among the founders and volunteers of the consumer coop analysed in the paper, enabling them to introduce direct experiences, in line with analytic auto-ethnography (Anderson, 2006).

Drawing on the two projects, the paper re-interprets AAFNs as SSE ecosystems through our tripartite analytical framework (i.e. inclusive innovation, agility, and resilience). This paper emphasises nation-wide patterns, with brief local examples. The information provides a basis for comparing the two national cases.

In both countries, the SSE-AAFNs sought to overcome inequalities, used agroecological production methods and often emphasised their environmentally sustainable methods to consumers. During the Covid-19 pandemic, several disruptions and constraints worsened inequalities, especially for lower-income groups. So, avoiding such a change was an achievement, warranting analysis. The next two sections present results on how they responded, taking each country in turn. Together they will be illuminated by our tripartite analytical framework.

5. BRAZIL: SSE-AAFNS ECOSYSTEMS

Let us begin with the case of Brazil. In this country, AAFNs are similarly called *Redes Alternativas Alimentares* (RAA). They are often called 'territorial markets', which build a territorial identity for linking various initiatives around agri-food quality and solidarity. Many AAFNs have arisen from a convergence between the *Economia Social y Solidaria* (ESS), EcoSol for short. Its global network has a Latin American section (RIPESS, 2013) with national and regional affiliates (e.g. FBES, 2021, 2022). Policies favouring the EcoSol-agroecology convergence have gained support from various mass movements.

5.1. BRAZIL'S ECOLSOL-AGROECOLOGY NETWORKS: BEFORE THE PANDEMIC

Brazil's networks previously promoting either EcoSol or agroecology converged to integrate them. As a turning point, in 2011 the National Agroecology Articulation (ANA) and Forum Brasileiro de Economia Solidária (FBES) jointly organised an event for linking the agendas of agroecology and solidarity economy (FBES, 2011; Schmitt, 2020, p. 39). Agroecological innovative producers were building local EcoSol networks, which raised their incomes, as well as conserving biodiversity and cultural heritages (ANA, 2012, p. 3). Conversely, agroecology was being incorporated into the EcoSol agenda (FBES, 2012).

Brazil's EcoSol-agroecology convergence has provided a support base stimulating SSE ecosystems (cf. OECD, 2020, 2023). This includes the Agroecology Association of Brazil (AAB) and Agroecology National Articulation (ANA). Support networks include agri-extensionists, both public-sector and third-sector, especially *Agricultura Familiar e Agroecologia* (AS-PTA). For EcoSol in general, policy officers have a parallel network promoting self-managed enterprises, democratic participation, and policy support measures (Rede de Gestores, 2018). This has regional affiliates, which often initiate proposals for national meetings. At the same time, Brazil's governments have supported *cooperativismo* with a neoliberal perspective, encompassing the rival aims of capitalist enterprises versus solidaristic ones (Pelegrini *et al.*, 2015).

The EcoSol-agroecology convergence has revived solidaristic mutual-aid practices, known as mutirão (joint work). This has been extended from traditional family or neighbour relationships to wider networks and contexts, including urban ones. In agroecological initiatives, reciprocity serves as a general means to enhance social integration, quality work, local culture, and communitarian belonging (Schmitt, 2020, p. 273).

As a long-time slogan, 'Without democracy, there is no agroecology'. Democracy provides means to overcome various inequalities, for example, by 'defending environmental justice, confronting the climate emergency, overcoming the racism and machismo that structure this unequal capitalist society; accessing common goods; recognising traditional communities which maintain them; and defending democracy'. Likewise, it means opposing agrichemicals, which threaten human health, the environment and agroecological methods (ABA, 2023). Together these aims have linked various groups in constructing AAFNs as SSE ecosystems much broader than producers.

But producers face low market prices through profit-driven middlemen, so they have sought means to retain more of the value that they add. They have built short food-supply chains (*circuitos cortos*), whereby consumer purchases support cooperative work organization and environmentally sustainable practices. They rarely sell 'agroecological' products, a term which is little known by consumers. The innovative products are variously promoted as, for example, peasant foods, poison-free products, true food (*comida de verdade*) or *produtos de bem* (in Brazil), or organic products whenever they gain certification (ANA, 2021).

Such innovative advances in *circuitos curtos* have depended partly on state support measures, especially during Brazil's governments led by the *Partido de Trabalhadores* during 2003-16. As intended, these policies jointly opened new opportunities for lower-income farmers to raise their incomes, especially through cooperative means. Likewise, for lower-income consumers to access agroecologiccal products.

Various mass movements have demanded pro-agroecology policies to help overcome socio-economic inequalities of race, gender and class. These have been manifest in widespread hunger and malnutrition, as well as dispossession from land, as highlighted by the small farmers' movement (MPA, 2021, p. 13). Likewise, such arguments come from the landless rural workers movement (MST).

There was a long-time civil society demand for Participatory Guarantee Systems, authorising organic certification based on a farmers' process of knowledge-exchange. This sociotechnical innovation, an *Organização de Controle Social* (OCS), was eventually authorised by the Agriculture Ministry (MAPA, 2007, 2008, 2020). The OCS option provides a low-cost solidaristic alternative to expensive third-party certification. Under the *Programa de Aquisição de Alimentos* (PAA), agroecological producers learned how to organize col-lective marketing.

A major opportunity has been public procurement for school meals through the *Programa Nacional de Alimentação Escolar* (PNAE). Public procurement drives sustainable innovation practices forwards. Public institutions pay a 30% premium price for organic and agroecological products, making these methods economically more viable for producers and likewise improving food quality (Grisa, 2009).

In parallel, agroecological initiatives have also established short food-supply chains directly to consumers, especially on the basis that their purchases support cooperative work organization and environmentally sustainable practices. Self-managed *Feiras de Agricultor* (farmers' markets) are Brazil's second largest retail outlet for food and a crucial outlet for agroecological producers (Matte Preiss, 2019). Community-Supported Agriculture provides regular food baskets for subscribers, while promoting seasonal food as more environmentally sustainable. Small-scale producers bypass conventional markets, rather than seek a futile competition on the same terms.

Those solidaristic markets, collective self-certification schemes and their public credibility have been facilitated by national support networks such as the *Rede Ecovida de Agroecologia*. Since 2006 this has done group training in skills for collective certification of agroecological products of organic (Ecovida, 2007). Through solidaristic cooperation, it has also advised agroecological producers on supplying food with the appropriate, quantity, diversity and quality for year-round contracts.

Producers have periodically agreed on product swaps, their prices and operational costs to be shared (Magnanti, 2008). Its member-producers have coordinated long-distance transport networks for flexibly swapping products from places where they are in surplus, thus maximising producers' income and consumers' food diversity (van der Ploeg & Schneider, 2012, p. 158-159; also Schmitt, 2020). This experience set high-profile precedents for local product swaps during the Covid-19 crisis.

As a long-time demand of EcoSol-agroecology movements, state support should help to overcome inequalities. Responding to such demands, agroecology policy has aimed 'to recognize women's contributions to maintaining ecosystems, and to help reduce gender inequalities through actions and programmes that promote women's economic autonomy' (Brasil, 2012; Planapo, 2013, p. 221). Long-time feminist networks were raising awareness of gender inequalities and building ways to overcome them. Women farmers' participation in territorial markets bring a knowledge component about their socio-economic relations and means to confront inequalities (Lopes *et al.*, 2022, p. 58). Through democratic self-management, they have organized collective marketing as

forms of inclusive innovation, facilitating the participation of marginalised low-income women (SOF, 2020).

5.2. PANDEMIC DIFFICULTIES, ADAPTATIONS AND LATER ADVANCES

For both EcoSol and agroecology initiatives, Brazil's support measures were degraded or dismantled by Right-wing governments after 2016 (Niederle *et al.*, 2019, 2023). In early 2020 the Covid-19 pandemic worsened prior socio-economic inequalities. Now producers had lower incomes, vulnerable families had difficulties accessing fresh food, and women faced greater burdens of care (SOF, 2020). EcoSol-agroecology networks faced new obstacles from hygiene requirements and supply-chain disruptions.

In March 2020 a fast response came from a Porto Alegre textile cooperative, UNIVENS, 'United We Will Win'. Adapting its production process, it quickly produced 600 facemasks for free distribution to health centres, *Feiras do Agricultor* and other public places. The fabric was donated by the *Justa Trama* (fair-trade loom) network, which routinely supplies organic cotton to UNIVENS (2020). This high-profile initiative inspired wider solidaristic responses.

For EcoSol-agroecology networks, the new hygiene requirements posed difficulties for the many Feiras, which needed fast adaptations. The new hygiene standards required several measures: disinfecting the food stalls, maintaining a minimum distance between them, wearing gloves and avoiding infection through product handling, packaging, plastic bags, electronic payment methods, etc. Farmers' markets are mainly sited outdoors; few have running water. They made special efforts to adopt hygiene measures; some markets had extra assistance from municipal authorities. But others could not comply with the regulations and had to shut down or move site or create alternative distribution methods (Preiss, 2020).

Such adaptations needed grassroots innovations, especially new communications-logistics systems, adapting social media for solidaristic aims. Their Facebook pages announced the new arrangements such as online orders and alternative pick-up points; they reached more consumers than before. However, commercially available apps were unsatisfactory for at least two reasons. Firstly, their standard design had no means to communicate the artisanal basis of the products on offer. Secondly, commercial app owners deducted a standard percentage of the sales. To avoid those problems, solidaristic tech experts or collectives helped to design alternative apps which could overcome those limitations.

As conventional retailers likewise faced disruptions, localised agri-food systems found a new opportunity, based on prior confidence between producers and consumers. They helped to innovate new products of family agriculture and various novel *circuitos curtos* (SOF, 20 21, p. 61). They devised innovative means to address all these problems together. Producers' incomes gained resilience by diversifying product combinations and sales outlets, while also building wider support networks (Calgaro *et al.*, 2022, p. 155).

When schools were closed down, some municipalities suspended the school meals programme. Others adapted it for provision to vulnerable families, responding to demands from local agroecological producers and solidarity networks. Solidarity networks emphasised that donations were solidarity rather than charity; this slogan was popularised by the landless workers' movement (MST, 2020; also Levidow *et al.*, 2022). All these efforts raised the profile of EcoSol as a broader solution to societal problems. EcoSol networks advocated this model for longer-term public policies to address poverty and malnutrition.

Beyond *circuitos curtos* per se, solidarity initiatives sought to strengthen the social fabric through knowledge exchange about natural medications, defence of common goods against territorial expropriation, and agroecological practices for self-consumption, donations and barter of surplus products (SOF, 2021, p. 74). For example, Slow Food Brasil created an interactive map of small-scale producers to facilitate such activities. The Brazilian Institute for Consumer Defence created such a map for bringing sustainable family farms closer to consumers (IDEC, 2020).

Those nationwide patterns are illustrated by one urban region, Borborema in Paraíba state. New forms of commercialization found an opportunity to demonstrate that family agriculture can produce healthy products at scale, or in sufficient quantity to supply the sales outlets at an accessible price for all social groups. The initiatives also created food baskets for donating to families in vulnerable conditions and which face hunger. These activities revealed the territorial capacities to construct innovative solutions for the challenges posed by the pandemic. They strengthened food systems that are decentralized, more inclusive and more connected with natural cycles (Kato, 2022, p. 94-95).

The pandemic worsened inequalities of gender, race, class and age. Especially affected were those who depended on agricultural work or had difficult accessing health services. Those who remained healthy, especially women and youth, faced greater burdens to care for others and to maintain solidarity bonds despite social isolation (SOF, 2021, p. 19). Through women's wider solidarity networks:

> "Care for Yourself baskets" provided a source of affection and security at a time when we lacked accurate information from the state and effective public policies. When I receive this basket, I felt was as if I were receiving a hug from each of the women who were inside that basket. Each one produced something, such as soap, a plant extract, homeopathy, oil. And that was like affection (SOF, 2021, p. 82)

Seeking greater gender equality in all spheres, the same activists recorded family members' time spent on domestic tasks and paid work, comparing men and women. Some initiatives extended the Agroecological Notebook method to record such time allocations alongside income, thus making women's contributions more visible and raising their self-esteem (Schmitt, 2020, p. 294). There was greater prominence for the long-time slogan, 'The Agroecological Notebook empowers women and strengthens agroecology' (Rody and Telles, 2021).

In all those ways, grassroots innovations provided agile, creative adaptations to deal with new obstacles. At the very least, they alleviated the general tendency for the pandemic to worsen inequalities; some went further by expanding the producers' income base and thus livelihoods. These responses built a transformative resilience, further extending solidarity networks. They have helped to avoid or overcome inequalities of class, race and/or gender; the emphasis was contingent on each locality and initiative.

5.3. URBAN PERIPHERIES: RESPONSIBLE CONSUMPTION GROUPS

During the pandemic, those grassroots innovations became more publicly visible, attracting attention from low-income groups in urban peripheries. These are known as 'food deserts', where fresh food is scare or expensive. People there have become dependent on cheap ultra-processed food from supermarkets, undermining their health (Honório, 2020).

For alternatives, some consumer groups had already been collectively purchasing agroecological products from peri-urban farmers for distribution to members, at prices much lower than organic food in supermarkets. These initiatives are often called a Responsible Consumption Group (GCR). They demonstrate the consumer benefits; they also do political education about multiple inequalities and how the GCR seeks to address them.

Let us focus on the São Paulo metropolitan area known as ABC. For several decades, local authorities had been urbanizing the land, raising the financial value and transferring it to new companies with tax exemption and other benefits. Enterprises superexploited labour to supply multinational companies. Housing policy was denounced as 'favelization': owners were parceling buildings into tenements with small units, neglecting their maintenance, turning them into slums and often evicting their residents. Protests

resisted evictions, occupied empty buildings and demanded land as sites to build their own houses (Silva, 2022, p. 70)

Together those struggles inspired the Rural Urban Consumption Collective (*Coletivo de Consumo Rural Urbano*) Diadema from 2014 onwards. It emerged from the Low-income Residents' Association of Housing Estates, Tenements and Renters of the Diadema West Region, indicating its class basis. The CCRU Diadema has highlighted the class exploitation experienced by family farmers and urban workers alike, as an extra reason for solidaristic bonds between them. (Silva, 2022, p. 89-133; Silva, 2023).

It sought to create a horizontal basis for democratic decisions with everyone's participation, partly through mass assemblies. These have addressed inequalities of gender, race and class. It highlighted how women's work was generally made invisible and devalued, warranting a collective struggle for solutions that would make everyone's lives more sustainable (*ibid.*, p. 154). Within the management group, all members had completed secondary school education, and 70% have been women; under half are white, similar to Brazil's racial composition (*ibid.*, p. 112).

Its warehouse has stored food deliveries so that members could assemble the weekly food baskets. It arranged food deliveries from agroecological cooperatives in peri-urban areas and distant semi-rural ones, who otherwise would face low prices. These cooperatives featured women quilombolos, i.e. descendants of escaped slaves.

When Covid restrictions disrupted their distribution system, the CCRU sought alternative means, especially online orders. It participated in the Class Solidarity campaign, organizing donations to needy families and indigenous groups (*ibid.*, p.121). More local groups formed in low-income urban peripheries.

To extend orders beyond Wi-Fi access, in 2021 the CCRU partnered with a computer-program enterprise to construct a cell phone app called CCRU Diadema. New WhatsApp groups dealt with various tasks, such as monitoring orders, arranging deliveries and paying suppliers. Staff developed a blog for general information about the collective such as its identity, activities, experiences, partner farmers, publications, recipes and nutritional information. Likewise guides for training and collective purchasing via the app. The tasks were done by a combination of paid and voluntary labour (Silva, 2022, p. 109; Silva, 2023).

As the pandemic subsided, in 2022 the CCRU resumed assembling the baskets in its own warehouse, now offering greater food variety than before. To accommodate greater consumer demand, more farmers were included; the larger support base continued after

the pandemic (Silva, 2023, p. 122). The rural-urban alliance helped to recover and popularise knowledge about using and conserving biodiverse natural resources for food production (Silva, 2022, p. 109; Silva, 2023).

In all those ways, CCRU Diadema has helped to valorize diverse knowledges and contributions towards better lives, while overcoming various inequalities. It illustrates how solidaristic AAFNs have been extended to lower-income groups through inclusive grassroots innovation, agile adaptation and a transformative resilience.

5.4. POLICY SUPPORT MEASURES: DECLINE AND REVIVAL

Those advances have depended somewhat on policy support measures, which were greatly increased or innovated during the first Presidency led by the Workers' Party (2003-2016). Afterwards Right-wing governments reduced or abolished such measures, so SSE-AAFNs had greater difficulty to expand or even continue. After Lula won the 2023 Presidential election, support measures were expanded or revived.

The new government relaunched its earlier National Agroecology Plan along with many support programmes. Its advocates praised their basis as inspired by popular experiences, national advisory groups and social participation. The measures would help to decentralize food marketing, to make high-nutritional food more affordable, to distribute more income to primary producers, and especially to valorize women producers (ANA, 2024).

In addition, Plan Safra 2023/2024 incentivised peasants to adopt agroecological production methods, to recover degraded land and to learn skills for *circuitos cortos*, especially through collective marketing. The Plan also increased purchases of agroecological food for needy families (MAPA, 2023). Such practices soon increased. SSE-AAFNs had maintained collective capacities to use the new measures in solidaristic ways. However, supporters criticised overly bureaucratic procedures for obtaining loans, likewise the small budgets relative to the great subsidy for agribusiness practices, which undermine family farms and degrade natural resources (MST, 2024).

6. TURKEY: SSE-AAFNS ECOSYSTEMS

Let us now turn to the case of Turkey. Beginning in the 2000s, this country had a rise of alternative agri-food networks (AAFNs), whereby short food supply chains sought to establish social proximity between consumers and producers. They have manifested a

grass-root level response to the challenges of neo-liberalization and deep market integration within an increasingly corporatized agri-food system (İnce & Kadirbeyoğlu, 2020; Büke *et al.*, 2023). These initiatives overlap with the SSE and its support networks; which have been proliferating in various forms (ActHuman, 2021b).

Since then, the number of these AAFNs have increased and their geographical distribution became more diverse, though most are still concentrated in three big cities; namely, Istanbul, Ankara and İzmir (Karakaya Ayalp, 2021, p. 990). Agri-food products have around 80 short supply chains in Turkey (Karakaya Ayalp, 2021). They take several forms, including producer and consumer cooperatives, collective kitchens, farmers' markets, urban community gardens, community supported agriculture schemes, etc. Traditionally known as *imece* in rural areas, mutual aid has been extended (without the term) for urban-rural linkages.

6.1. TURKEY'S AGRI-FOOD COOPERATIVE ECOSYSTEM: BEFORE THE PANDEMIC

Cooperatives and their networks represent an early example of collective solidarity in Turkey. There are about 60,000 cooperatives with 6.6 million members, operating mainly in housing, construction, transportation, food, and agriculture (ActHuman, 2021b, p. 23). Cooperatives there traditionally have been heavily dependent on public sector support, enabling the state to intervene in their operations, limiting their autonomy.

Recently, however, 'there have been efforts towards transforming cooperatives at the grass roots level, apart from the practices of the public at the level of central and local administrations' (ActHuman, 2021a, p. 3). These efforts have enabled cooperatives to develop some autonomy from the state. More recently, municipalities' procurement has helped build solidaristic relations with cooperatives as partners within the SSE ecosystem, developing horizontal relations rather than creating dependencies.

In Turkey, agricultural cooperatives take several forms such as agriculture sales cooperatives, credit cooperatives, development cooperatives, to name a few. Although a patchy neo-liberalization of the agriculture sector has been ongoing since 1980s, this accelerated since 2000s, with the World Bank financing an Agriculture Reform Implementation Project (Aksoy, 2010). As a result, some cooperative unions—such as Pankobirlik, the sugar beet cooperatives union and Tarım Kredi Kooperatifleri Birliği (Agriculture Credit Cooperatives Union)—have followed the trend of corporate control and financialization. By contrast, other cooperatives have undergone a reorganization with the aim to strengthen solidaristic principles (Yeneroğlu & Aykaç, 2021, p. 141). Tire Dairy Products Coop (established in 1967), and Hopa Tea Coop (established in 1959) exemplify old agricultural deve-

lopment coops seeking to resist this strong wave of neoliberalism (Hacısalihoğlu & Şahin, 2019, p. 79-80).

Parallel to these examples of regenerating rural cooperatives, recently established urban consumer cooperatives complement more sustainable forms of urban-rural relationships. Although some of these express affluent urbanites' search for healthy food, others explicitly adopt the principle of food sovereignty, which goes beyond direct producer consumer interaction; providing the first steps for a solidarity economy. These novel forms of 'solidarity-based economy initiatives' aim to establish reciprocal, trust-based relations between diverse actors (producers, consumers, civil society organizations) as a means to avoid the problems from the market-driven food system (Pelek & Gajac, 2020, p. 112). These initiatives are characterized by non-hierarchical organizational structure, volunteer work, democratic decision-making and democratic participation (Öz & Aksoy, 2019; Kadıköy Cooperative Collective, 2020).

Despite their differences, all these initiatives share "their determination to have independence in accessing healthy and affordable food in creative, fair, and experimental ways" (İnce and Kadirbeyoğlu, 2020, p. 8). They select producers according to criteria such as sustainable production processes (no use of chemical inputs, use of local/traditional varieties of seeds), non-exploitative labour (fair wages), and small-scale farmers.

These criteria do not entail organic certification, which is too costly for small scale farmers, even if their production methods conform to the organic requirements. In this regard, we can take the case of a university-based consumer food coop, Bogazici Members Consumer Coop (BÜKOOP), supplied by small farmers. Many cannot afford to get organic certification, despite their commitment to ecological and organic production. This has important implications on the consumer side as well, since organic products are considerably more expensive.

Such considerations have led BÜKOOP to encourage instead alternative certification mechanisms such as 'participatory guarantee systems' (PGS) based on mutual trust, in an attempt to support agroecological practices of small-scale farmers to sell their produce at fair prices, while also enabling consumers to access high-quality products at affordable prices (Öz & Aksoy, 2024). In that way, many AAFNs prioritize solidarity with small farmers, giving special attention to women producers and recognizing their labour (Soysal Al, 2020). This centrality of solidarity to address class and gender inequalities goes beyond small-scale producers; Kadıköy Cooperative, for instance, "supports many disadvantaged communities, such as Migrant Women, Kazova workers, and Kadın Kadına Mülteci

Mutfağı [The Women-to-Women Refugee Kitchen], by selling their prepaid products on their solidarity shelf, separate from the ecological food shelves" (Soysal Al, 2020, p. 146).

In short food supply chains in İzmir, some small farmers received various types of support. In particular "rural-rooted and very small-scale farmers, which were mostly attached to more formal networks, mentioned a bigger change in their livelihoods" (Kurtsal *et al.*, 2020, p. 216), and "gained more visibility and respectability" (Kurtsal *et al.*, 2020, p. 214). For producers engaged in what the authors call 'food community networks,' and for many of whom agriculture is not the sole source of income, establishing and strengthening social ties and participating in the network seem crucial (Kurtsal *et al.*, 2020). Therefore, AAFNs have diverse forms and effects on different farmers' groups as regards economic and social equality.

Small scale producers face difficulties from market driven competition in a sector that is permeated by retail chains, increased industrial agricultural production and monopolistic structures in setting prices for agricultural inputs, all intensified by neoliberal policies (Öztürk *et al.*, 2018). To help resist such pressures, more local administrations have developed innovative support measures (Oba & Özsoy, 2024). Some municipalities support rural-urban solidarity initiatives, e.g. through more attractive products and short food supply chains.

İzmir has been a pioneer in this process. İzmir metropolitan municipality does not provide direct financial support or grants but does help small producers strengthen their capabilities for self- organization, as well as support producers' cooperatives via purchasing arrangements (Yıldırım 2020, p. 46). Beyond producers per se, the municipality purchases their products to supply lower income groups in need through staple food products such as milk, olive oil, yoghurt, cheese and potato (Yıldırım 2020, p. 46-47). To revive a traditional wheat variety, Izmir's local Seferihisar municipality supplied seeds to the producers and guaranteed purchases at a fair price through a social cooperative (Nizam & Yenal, 2020, p. 757).

Some provide market spaces for small-scale producers to facilitate their economic participation. For example, İzmir has restored a municipal building for use by an Urla women producers' market every Saturday (Aykaç, 2022). Bursa's Nilüfer municipality has an international city food system planning project (https://fusilli-project.eu), which seeks to establish a network of Living Labs in 12 European cities for open innovation; the project does a multi-scale coordination of various actors including farmers markets and community supported agriculture schemes (Karakaya Ayalp, 2023).

Ovacık Municipality played a pioneer role in the establishment of Ovacık Agricultural Development Cooperative. This has played a crucial role in reviving agricultural production in the region. By organizing producers, the cooperative generated employment opportunities in both the countryside and the town centre (Göçer, 2021). Through municipal support, some villages established collective production; they used the income to provide student scholarships and financial support to families in need (*ibid.*).

Those examples show the importance of a multi actor network in the SSE ecosystem in order to enable rights, equality, cooperation and solidarity. All those innovative measures help to resist the neo-liberalization that is promoted by national policies.

6.2. PANDEMIC DIFFICULTIES AND ADAPTATIONS

To address the pandemic, in March 2020 Turkish government took measures which included: suspending face-to-face education; closing public spaces; and lock-downs initially for the elderly, later expanded to include everyone in metropolitan cities. The measures affected various economic sectors including agriculture, food and beverages (Tuysuz *et al.*, 2022, p. 1135). The government's agricultural policies, which had long been rooted in neo-liberalization of the economy, were now criticized by numerous professional organizations; specifically, the reductions in subsidies to the agriculture sector at a time when protectionism was gaining momentum globally (Ertekin & Yıldızcan, 2023, p. 161).

As the pandemic harmed most economic sectors in Turkey, cooperatives faced challenges, too, largely due to public health safety measures such as lock-downs and interruptions in supply chains (ActHuman, 2021a, p. 4). Both measures worsened inequalities, in particular with regard to gender and class. In women's cooperatives in the Western Mediterranean region, for instance, members experienced both financial and social difficulties due to restrictions caused by the pandemic; their production was severely affected and there were disruptions in supply chains (Demircan Yıldırım, 2022).

Under these difficult circumstances, cooperation became even more necessary, as explained in the following statements of a co-op member: "Before the pandemic our sales were overwhelmingly to visitors to the village. Since the pandemic, 99% per cent of our sales are through other co-ops, consumer purchasing groups, etc." Here, most of these sales were conducted "via telephone ordering, Internet, Instagram, etc.". For women cooperatives this intensified a challenge that had already become an issue before the pandemic: namely, the weak capacity to build and operate online platforms for greater reach and sales. Many women co-operators lacked the technical skills to conduct such activities, though there were exceptions (e.g. Öz & Aksoy, 2024).

Pandemic restrictions also increased the importance of agile responses from a multi-actor solidarity network supporting women cooperatives. Kadın Emeğini Değerlendirme Vakfı (KEDV), an association linking women producers, illustrates the SSE ecosystems approach. KEDV plays a key role in providing platforms for women's coops to come together, for example, by organizing seminars and workshops in different provinces of Turkey. Such activities created opportunities to form networks, to share and improve skills and practices, and to enable them to connect with women from diverse income groups and ethnic backgrounds (Çınar *et al.*, 2021; Öz & Aksoy, 2024). 'To keep going, we need to hold each other's hands', said a woman co-operator from Vakıflı coop in Mediterranean Turkey (Capar, 2023). The prompt response of KEDV was very effective in serving to coordinate and strengthen the solidarity networks among women cooperatives during the pandemic (Demircan Yıldırım, 2022).

Gender and class inequalities might be intertwined, as illustrated by Vakıflı women's coop in Mediterranean Turkey. The pandemic forced them "to stop and think" about the prevalent inequalities in sharing the benefits. In the words of a co-operator:

> Before the official women's co-op, there was a duality between those who could contribute more capital and thus could produce more, earn more, and those who couldn't. During the pandemic, however, when sales to tourists practically stopped, since there were hardly any visitors, this problem became more obvious. We also had more time to think about how we could find a way out of this. Establishing an official co-operative, we decided, could enable us to re-organise everything. And that's how we developed a system that enables each member to be equal partners in profit or loss of the co-op, regardless of her means. In the new system, members make sure that every house in the village benefits from our common effort in the co-op, while those who work more get additional benefits (Capar, 2023)

At the same time, carrying all the domestic burden in times of crises, women co-operators emphasized the "care" and "affection" that emerged from their collective efforts; they find the "cure" in their cooperatives. In Hatay, a province which was hit severely by an earthquake in 2023, when they were still struggling to recover from the pandemic, a woman co-operator said the following:

> Economic benefits are of course very important, but it also feels very good to be together, to work together. I can give the example of the aftermath of the earthquakes. When we couldn't recover psychologically, the co-op healed us in a way. We as the women's co-op made everybody work, participate. You know, working heals you. The co-op there-fore provided means for people to recover (Capar, 2023)

In a similar vein, said another co-operator, "Working together in the coop is like therapy. It kept me on my feet in these difficult times". (Kartun, 2023)

In those ways, SSE-AAFNs provided economic benefits supporting the income base and livelihoods of their participants that proved especially critical during the pandemic. In addition, AAFNs played significant roles in supporting their members socially and psychologically, which in turn reinforced their resilience. At the same time, this resilience can only be maintained and strengthened via an SSE ecosystem with the involvement of multiple actors, including but not limited to public authorities, that bolsters these practices (Kurtsal *et al.*, 2020; Atalan-Helicke & Abiral, 2021).

6.3. URBAN FOOD COOPERATIVES

For consumer food cooperatives and other arrangements in cities, the pandemic imposed delays in establishing novel forms of short supply chains as well as in continuing current initiatives. For example, a newly established consumer food coop in Istanbul, Beşiktaş Coop, had just opened its shop when the pandemic hit; they could not admit consumers or hold face-to-face meetings with members, and so faced a setback from the very start (Sosyal Ekonomi, 2022). Despite such hardships, many food cooperatives managed to survive, thanks to several features: their earlier collaboration in the preparatory phase of the coop; their rapid agile adaptation; continuing their open call through routine meetings online; and their effective use of social media to reach consumers (Yeşil Gazete, 2020).

Based on their earlier experiences and relations of trust, food cooperatives quickly developed agile means to address the pandemic challenges. BÜKOOP devised a prepayment system to ensure the product supply would continue (Öz & Aksoy, 2024). The Natural Food Network and many neighbourhood cooperatives prepared solidarity food packages for those in need to enable uninterrupted access to food (Atalan-Helicke an&d Abiral, 2021).

Given its success during the early days of the pandemic, Natural Food Network was invited by Ankara Municipality to develop a model for access to markets by nearby small farmers (Atalan-Helicke & Abiral, 2021, p. 97). Coupled challenges of the pandemic as well as the severe economic crisis also led BÜKOOP to provide fruits to university students at a subsidised price. This was made possible with the support of producers, BÜKOOP volunteers and non-student buyers (Öz & Aksoy 2024); such cooperation has later continued, adding other products.

After the pandemic, however, some neighbourhood consumer coops in Istanbul had to close down. As plausible reasons, they faced macro-economic problems such as high rents and inflation, alongside excessive administrative burdens running their opera-

tions. More fundamentally, AAFNs face strong market competition as the agri-food sector becomes ever-more neo-liberalized.

6.4. SSE-AAFN ECOSYSTEMS: OVERVIEW AND LIMITATIONS

During the pandemic, producers in general managed to increase their sales by supplying niche markets and engaging or initiating short supply chains. AAFNs increased sales, especially as affluent urban dwellers sought healthy and quality food (Keyder *et al.*, 2020). Rejuvenated cooperatives and their collaboration with municipalities helped lower-income groups to access fresh, healthy food (*ibid.*). So an SSE ecosystem was crucial for overcoming inequalities.

Through the pandemic experience, the SSE-AAFNs ecosystem flexibly adapted practices to the new conditions by using digital tools and social media in diverse ways and for multiple purposes. Many have been using these relatively novel tools to realize the common goal of providing and accessing healthy food on fair terms under crisis conditions. Importantly, this effort was enabled by the trust that has been built over the years with democratic, participatory organizational processes.

Despite several challenges, Turkey's SSE-AAFNs ecosystem successfully engaged with other actors such as local administrations. Some producer and development cooperatives changed their priorities towards emphasising closer relations with consumers based on solidaristic ties, especially for alleviating social inequalities. They overcame distrust from the earlier efforts at building cooperatives which generally could not deliver economic or social benefits to its members, given their dependence on the public sector.

At both the production and consumption stages, they generated greater care and affection; this softened the impact of the demoralising difficulties, especially those associated with the pandemic. The examples here describe how the SSE-AAFN ecosystems gained capacities to realize their goals and provide healthy, affordable food without disruption during the Covid-19 crisis. This capacity has long-term implications for a transformative resilience of the agri-food system.

In recent years Turkey's cooperative movement has brought together diverse institutional actors through platforms, and networks. These multi-stakeholder structures operate informally, sharing knowledge and experience. However, they remain 'at an embryonic stage', unable to upscale their joint activities (Adaman *et al.*, 2025).

7. COMPARATIVE ANALYSIS AND CONCLUSION

This paper has theorised how inclusive grassroots innovation responds to socio-economic inequalities and facilitates efforts to overcome them, contingent on solidaristic relationships. By juxtaposing a literature review with two national cases, this paper showed how some AAFNs with their support networks serve as Social Solidarity Economy (SSE) ecosystems, here called SSE-AAFNs for short. Based on principles of democratic self-management and mutual aid, SSE-AAFNs have developed inclusive grassroots innovation in various forms. Their collective capacities help overcome or avoid social inequalities (of class, gender and race). Given that SSE ecosystems were originally seen as solidaristic interdependent actors (OECD, 2020, 2023), here we have deepened the concept by highlighting inclusive grassroots innovation as central to their beneficial roles.

As outlined above, AAFNs in Brazil and Turkey have such similarities alongside their differences. Both have benefited from civil society groups, especially women's networks, within wider SSE ecosystems. Both have demanded and gained support measures from municipalities, along lines helping to build collective capacities rather than dependence. In each country, the relevant organisations cooperatively developed dynamic capabilities through solidaristic commitments and democratic self-management. Through those capabilities, they have improved sustainable agri-food practices, managed knowledge exchange within SSE ecosystems and developed short supply chains.

Moreover, they creatively adapted and extended those distribution methods during the Covid-19 pandemic. The health risks made many people feel anxious about food safety in conventional food chains (especially supermarkets), and so raised interest in alternative sources. Going beyond safety issues, SSE-AAFNs used the opportunity to reassure and educate people about sustainable, equitable production methods. Many new consumers continued a supportive role after the pandemic. This solidaristic expansion can be (and remains) a general role for inclusive grassroots innovation beyond an emergency. SSE-AAFNs have maintained or created short supply chains which can avoid profit-driven middlemen, increase producers' incomes, and minimise prices for lower-income consumers, as in responsible consumption groups.

Solidaristic aims, methods and inclusive grassroots innovation were extended by lower-income groups in urban peripheries to address their food needs. This exemplifies how wider SSE ecosystems responded in many other sectors and places, helping them to address social inequalities. As a major difference between the two countries here, Brazil has had a relatively greater convergence of social movements offering mutual support,

developing collective capacities, demanding policy support measures (especially at national level) and using them to strengthen solidaristic bonds alongside better livelihoods.

7.1 TRIPARTITE ANALYTICAL FRAMEWORK

To explain how SSE-AAFNs adapted to adverse contexts and used them, this paper elaborated a tripartite framework: grassroots innovation, agile adaptation and transformative resilience. The three parameters generally overlap in specific practices. Nevertheless let us recapitulate the parameters in turn, clarifying how each one helps to resist the hegemonic system and thus has wider significance for solidaristic innovation.

Inclusive grassroots innovation:

Non-capitalist economic initiatives, which sometimes overlap with grassroots innovation, have inspired efforts to expand such alternatives towards a solidaristic future. However, many such initiatives encounter difficult tensions with conventional markets; some have become marginalized, co-opted or subsumed by the hegemonic economic system (Hess, 2007; Fressoli *et al.*, 2014; Robra *et al.*, 2023). This paper has shown how some SSE-AAFNs have been maintained through wider SSE ecosystems, partly by embedding inclusive grassroots innovation (cf. Billiet *et al.*, 2021; Roysen et al, 2024).

SSE-AAFNs have sought to overcome social exclusion from decent livelihoods and healthy food. Their novel practices have given broader meanings to traditional rural concepts of mutual aid; such practices go beyond family or neighbour relationships to new contexts including urban ones. They have innovated agroecological production and distribution methods which can benefit lower-income and socially marginalised groups.

A care ethics has been globally developed across the places and spaces connecting food producers, consumers and environments, e.g. for a pesticide-free countryside (Goodman & Goodman, 2009). Women in particular have played leading roles by enabling greater inclusion and extending care relationships. Through democratic self-management, they have organized collective marketing, often using new electronic tools. Meanwhile they facilitated participation by otherwise marginalised low-income people. Through grassroots innovation, SSE-AAFNS made adaptations for several aims; to minimise or overcome inequalities, to enhance their members' stability, and to extend short supply chains; many continued after the pandemic.

Agile adaptation:

During the Covid-19 pandemic, many conventional agri-food chains demonstrated and emphasised agile adaptive responses. For example, some supermarket chains innovated or extended online ordering systems, especially through mobile phones (Machado, 2022). These maintained socially distant, anonymous relations between producers and consumers.

By contrast, in both countries, SSE-AAFNs innovated agile means to extend solidaristic relations during the pandemic. They had to address broken supply chains, lockdown regulations and communities affected by illness and lost income. As general characteristics of SSE ecosystems, their prior routines, collective capacities and solidaristic mutual-aid relationships were quickly mobilised for creative, adaptive responses.

Collective marketing coops maintained or expanded their sales by innovating digital communications, especially social media for promotion and apps for orders. Some expanded their consumer base through novel products or combinations. Solidaristic IT groups helped to design apps for those aims. Some adaptions were no longer necessary after the pandemic. Others continued, such as online ordering systems, also serving a political education role. An adaptive agility complemented a transformative resilience.

Transformative resilience:

During the pandemic the agri-food industry highlighted its resilience for a rapid 'return to normal', aka bouncing back to its previous state. Representing global elites, the World Economic Forum promoted various technofixes for strengthening the resilience of the dominant food system (Fraser *et al.*, 2020), in ways minimising dependence on human labour. Anticipating future crises, it proposed to enhance 'food-system resiliency' through 'data-driven' information platforms, especially by integrating small-scale farmers into distant markets (WEF, 2020).

By contrast, SSE-AAFNs used the Covid-19 pandemic as an opportunity to strengthen solidaristic bonds among producers and with consumers, through support networks beyond their members. SSE ecosystems were demonstrated here for the two case-study countries. Such actors were resilient in two main ways. First, they used their greater income as a means to fulfil their social mission; they continue their production or service delivery for their members in times of crisis to sustain their needs, livelihoods and well-being. Second, they were further embedded in local communities, as well as linked with a wider movement that inspires them (Billiet *et al.*, 2021).

As SSE ecosystems, some AAFNs deepened and expanded solidaristic bonds. We have analysed this shift as a transformative resilience bouncing forwards (cf. Manyena *et al.*, 2011, p. 3). The concept can theorise many solidaristic practices during the pandemic. It helps solidarity networks to open up collective pathways towards better futures.

7.2. BARRIERS VERSUS SUPPORT

As many SSE-AAFNs continued during the pandemic, they still faced structural limitations. A main barrier lies in the dominant political-economic forces, especially the agri-industrial food system perpetuating socio-economic inequalities. Major barriers include:

- Hierarchical governance: Conventional food-supply chains perpetuate a hierarchical governance of power relations. Centralized distribution systems perpetuate anonymous, socially distant relationships.
- Hegemonic markets: Market pressures perpetuate structural injustices such as unemployment, low-wages and private ownership. A strong political force would be necessary to displace those dominant roles. SSE-AAFN ecosystems cannot substitute for such a force.
- Adverse policy frameworks: The dominant agri-food system benefits from favou-rable support measures such as subsidy, procurement criteria, infrastructure (e.g. irrigation, ports for exports) and R&D priorities (for capital-intensive innova-tion). Market pressures readily marginalize SSE-AAFNs or pressurise them to accommodate the profit motive.

SSE-AAFNs can better flourish in a favourable policy-institutional environment. To overcome barriers, helpful measures would include the following: public procurement criteria favouring agroecological food; skills training for collective marketing; flexible regulations for hygiene and certification (organic or agroecological); agri-extension services facilitating materials recycling and higher-value products; infrastructure for storing and selling products, including transport from peri-urban areas; technical assistance for online ordering systems enhancing consumer knowledge. Such measures can help SSE-AAFNs to expand, for example: outscaling (replication), upscaling (enlargement) and/or creating rural-urban links across greater distances.

Solidaristic AAFNs have faced tensions and dilemmas, more subtle than barriers. According to a survey of non-profit agri-food networks: 'Tensions between idealism and pragmatism come up when organizers feel conflicted between observing the principles

they set out for the initiative and adapting or forgoing those principles for practical reasons. Indeed, their environmentalist, solidaristic principles often conflict with options to generate income. Several mentioned 'the pioneering nature' of their initiatives, seeking to clarify their alterity from conventional agri-food chains. Some emphasised that non-profit AAFNs depended on various external groups to help overcome barriers and find new opportunities (Ribeira *et al.*, 2021, p. 503; cf. Öz & Aksoy, 2019).

In those ways, SSE-AAFNs have helped overcome or avoid social inequalities through inclusive grassroots innovation. Members' democratic participation has played crucial roles: in defining issues, planning activities, extending mutual-aid practices, demanding policy support measures, using them effectively and thus gaining collective empowerment.

Beyond AAFNs, the tripartite framework here has wider relevance to SSE ecosystems. It can help them in several ways: to identify parameters that may otherwise remain latent; to develop strategies for strengthening and integrating them; to resist being marginalized or co-opted by the hegemonic system of competitive markets; and to advocate support measures which serve those aims.

Table 1. Comparing SSE-AAFNs in Brazil and Turkey.

	Brazil: EcoSol-agroecology	Turkey: Agri-Food Ecosystem
SSE ecosystem: main national networks. Socio-political forces Women's networks and empowerment.	Practical convergence of ANA (agroecology)+ FBES (EcoSol) agendas with advice-support networks, e.g. Red Ecovida, Mass movements of low-income peasants (MPA), landless rural workers (MST), environmentalists, quilombos, feminists, etc., alongside networks of agri-extensionists and public policy officers. *Sempreviva Organização Feminista* (SOF) linking various feminist networks.	*Sosyal Dayanışma Ekonomileri:* informal network of old and new-generation cooperatives as a bottom-up process for establishing an SSE. Growing social movements, e.g. Farmers' Union (Çiftçi-Sen), environmentalists and urban alternative food networks *Kadın Emeğini Değerlendirme Vakfı (KEDV):* Association valuing women's labour by finding marketing opportunities.
Grassroots innovation: esp. short supply chains. Higher price for agroecological products. Mutual-aid extended.	Collective marketing initiatives and consumers' coops. *Sistemas Participativos de Garantia* (SPG) help gain collective self-certification of agroecological products as organic through an *Organização de Controle Social*. Benefits to disadvantaged communities as producers and consumers. *Mutirão* among producers and for urban-rural linkages	Collective marketing initiatives and consumers' coops. Participatory Guaranteed Systems help gain a higher price for agroecological products (though not the premium price for organic). Benefits to disadvantaged communities as producers and consumers. *Imece* (without the term) was extended from rural contexts for urban-rural linkages.
Agility: short supply chains adapting.	Fast adaptations reconciling hygiene restrictions with the previous and new consumer base, esp. via digital ordering systems.	Fast adaptations reconciling hygiene restrictions with the previous and new consumer base. For example, pre-payment schemes in food coops.
Resilience bouncing forwards.	Adaptations extended solidaristic relationships between producers-consumers. Care roles softened difficulties of pandemic.	Adaptations extended solidaristic relationships between producers and consumers. Care roles softened difficulties of pandemic.
Public policies: National policies. Local government.	Support mainly agribusiness, with smaller programmes supporting EcoSol-agroecology. Support *cooperativismo*, favouring capitalist enterprises as well as alternatives. Some local authorities and extension services have helpful measures, extending supportive national policies.	Support agribusiness. Neoliberal policies have aimed to integrate coops (including AAFNs) into competitive markets, contrary to SSE aims. Some municipalities have offered helpful support measures, despite neoliberal national policies.

Source: elaborated by the author.

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The Human and Social Factors of Technological Innovations

Risks And Resources Analysis Model

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ABSTRACT

The theoretical article is devoted to the human and social factors of innovations. This is due to the fact that innovation is an increasing and inevitable trend of our time, with deep impacts on society, on nature and on individuals. At the same time, innovations are related to the area of large economic risks and have quite pronounced contradictions, including in the psychological context. The article reveals the basics of studying the psychological context of innovation and the main risks associated with such a context, drawing attention to the need of developing conceptual approaches to better understand this phenomenon, as well as proper policy frameworks that address innovation under these emerging views. As a result, the author's model for the analysis of risks and innovation resources is presented. The model includes three levels of analysis: the macro level (socio-cultural and institutional factors), the meso level (company level), and the micro level (a person as a subject, creator and/or consumer of innovations). This approach allows us not to make too sharp distinctions between the social, psychological and economic factors of innovation.

Keywords: Attitude to Technological Innovations; the Impact of Innovation on Personality; Risks and Resources of Innovations.

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INTRODUCTION

At the beginning of the 20th century, Josef Schumpeter proposed the concept of "technological innovation". Innovation may be defined as exploiting new ideas leading to the creation of a new product, process or service (Schumpeter, 2004). The term "innovation," originating in Ancient Greece, has changed its meaning (and translation) several times over the centuries: from changes in order as a political phenomenon, to Reformation, from heresy to economics. As Godin rightly noted, "the discourse on technological innovation espouses a semantic that has deep roots in history". (Godin, 2021 p. 11). Clearly, changes in language and vocabulary indicate changes in values.

Innovation, as precisely defined by the OECD, involves implementing new or substantially enhanced goods, services, processes, marketing strategies, or business/organizational methods. Although definitions vary, the OECD's formulation is particularly comprehensive, capturing the essential nature of economically beneficial new activities. The scope of what constitutes innovation under this definition is cataloged annually in the Global Innovation Index.

The concepts of technology, technological innovation, and STI policies are so intertwined that they also require definitions. To avoid a lengthy terminological debate, in this article we will adhere to the definitions (taken in short) of the Russian Federal State Statistics Service (Rosstat). *Technology* is defined as the application of scientific knowledge to practical purposes or applications. Technology utilizes scientific principles and applies them to change the human environment. Technology can also use scientific principles to advance industry or other human-made endeavors. *Innovative technologies* represent a comprehensive set of methods and tools. They enable the introduction of innovations—improved products, goods, or services. They are aimed at increasing product quality or the efficiency of personnel or factories. *Innovative activity* is the transformation of ideas (usually the results of scientific research and development or other scientific and technological achievements) into technologically new or improved products or services introduced to the market, or into new or improved technological processes or methods of producing (transferring) services used in practical activities. *Innovative goods, works, and services* are goods, works, and services that are new or have undergone varying degrees of technological (or biological) change within the last three years.

Marketing innovations are the implementation of new or significantly improved marketing methods, encompassing significant changes in product design and packaging, the use of new sales and presentation methods for products (services), their presentation and promotion in markets, and the development of new pricing strategies. They are aimed at more fully satisfying consumer needs, opening up new markets, and expanding the consumer base for products and services in order to increase sales. *Organizational innovations* are defined as the implementation of a new method in conducting business, organizing the workplace, or managing external relations. These innovations are aimed at improving organizational efficiency by reducing administrative and transaction costs, increasing employee satisfaction with the organization of the workplace (working time) and thereby increasing productivity, gaining access to assets unavailable in the market, or reducing supply costs. An organization does not necessarily have to be the first to implement these organizational innovations. It does not matter whether the innovations were developed by your organization or by others.

First of all, we are talking about technological innovations. Technological innovation is underpinned in technology, which is driven by inventions of new things and are transformed into usable innovations in markets to satisfy (Coccia, 2021). It is not just the invention of a new idea that is important. It is actually "bringing it to market", putting into practice and exploiting it in a manner that leads to new products, services or systems that add value or improve quality. Competition through innovation, Schumpeter argued, is the driving force of economical development.

The importance of innovation is increasing and increasing significantly. In the current economic scenario, innovativeness has become a major factor in influencing strategic planning of companies, public institutions, governments—it has been noted that the generally positive belief in innovation nowadays leaves deep marks in our collective imaginary, at the same time influencing and legitimizing decision-making and public policy design (Global Innovation Index, 2024).

Today we interact daily with the artifacts, infrastructures and systems around us. Megacities, complex transportation systems and the intertwined chains of production-circulation-consumption of goods and services are just a few examples of arrangements of which technology is a fundamental constituent element. However, although surrounded by these elements, we rarely think about the presence of such values in the constitution of the technological dimension of our world.

Of course, the social and psychological reflection of innovation has been taking place for two decades. For example, these are the ideas of broaden the role of the social sciences in technological governance (Macnaghten *et al.*, 2005), also acknowledgement of the importance of privacy in technological and digital innovation (van den Hoven, 2013). If philosophy is the attempt "to understand how things in the broadest possible sense of the term hang together in the broadest possible sense of the term", as Sellars (1962) put it, philosophy should not ignore technology.

The idea that technology is not neutral and actively shapes our values and lives is central to the philosophy of technology, from its early stages of development to modern discussions (Heidegger, 2025). The philosophers of technology (Verbeek, 2021; Ihde, 2022) develop this idea by exploring how technological artifacts not only serve us, but also actively influence our understanding of the world, our actions, and our identity (Leite *et al.*, 2024).Thus, the philosophy of technology emphasizes that technology is not neutral, but actively shapes our being and values. And these relationships are two-way.

We can also give an example of a multidimensional approach to evaluating innovation, which further highlights the value of the human factor (Owen *et al.*, 2021). If, as many people claim, innovation is all around us, we still fail to grasp its exact meaning. This is due to the fact that technologies are developing much faster than society or scientists (psychologists, sociologists) can reflect on, analyze, assess risks and resources. Cultural parameters, not on a global or national level, but on an organizational or group level, may have the greatest influence on an individual's perception of the concept of innovation. The concept of innovation develops within the micro context in which the individual is embedded (Frogeri *et al.*, 2021; Patrakov et al., 2022). Stylized versions of the idea of innovation influence both technophobic and, most commonly, technophilic views.

Given this importance of the idea of innovation, the critical study of the human factor of innovation, the role of humans as creators of products, the influence of the social and cultural environment, as well as the psychology of the consumer plays a significant role both in the development of innovation and in its psychological reflection.

Mobilizing and integrating a diverse set of academic literature, this paper aims is to review the publications on the Problems of the Human and Social Factors in Technological Innovations and to propose a multidimensional and consistent model for analyzing the risks and resources of innovation, taking into the human and social factors.

The first section of the paper provides a very brief contextual overview related to the ever-growing presence and perceived relevance of technology and innovation in the contemporary world. The second section focuses on the psychological dimension of technological innovation (or, rather, how technological change affects psychological aspects in modern societies). The core element of risk as a source of psychological implications of innovation is further developed in the third section of this paper. The fourth section explores how these implications relate to public policies, particularly science, technology and innovation (STI) policies. This is followed by a brief section of concluding remarks and model for analyzing the risks and resources of innovations. We believe that the value of this model will lie in the fact that it can be applied in the practice of analyzing specific innovations, in the practice of real startups.

1. INNOVATION IN OUR TIME

Modern society is characterized by an increasingly accelerating rate of scientific and technological progress and the massive introduction of innovations in all spheres of economic activity. The change in the technological order associated with the fourth industrial revolution and Industry 4.0 requires enterprises, organizations, and states to form long-term competitive advantages and carry out digital and technological transformation.

The Web 1.0 era provided the development of infrastructure for transmitting information and for providing global connectivity, impacting the economy, culture, science. The Web 2.0 era was characterized by much more interactivity: people have started communicating with each other on the Internet, interacting with other people, collaborating with them, and creating, sharing and consuming content themselves. This period was dominated by social media and various web-based applications. This type of behavior was called "Resident behavior", which referred to people leaving social footprints on the Internet.

The next stage is Web 3.0; this phase is in the process of being formed. It has elements like the internet of Things (IoT), Big Data, Artificial Intelligence (AI), Virtual Reality (VR), smart e-devices (phones, watches, e-homes). Most professionals predict that the physical (real) and virtual worlds will converge and will probably merge at some point; and this new connected world will be a part of our everyday lives. And it is not going to happen in the distant future, but it is happening right now, in our present.

So, the technological development that began in the 18th century, accelerated in the 19th, advanced in the 20th, and introduced advanced automation in 21st century, has come to such level that the human society was no longer able to properly follow technological innovations. The current times and the very near future are characterized by a significantly larger number of innovations and their diversity, even if their actual potential for promoting the change heralded by the positively biased innovation narrative has often disappointed (Winner, 2018).

The *Global Innovation Index 2023* (GII, 2023) gauges global innovation trends in the context of an economically uncertain environment. It unveils the rankings of the most innovative economies worldwide among 132 economies and identifies the top 100 science and technology innovation clusters. More than two thirds of the indicators in this rating include digital indicators. As countries and businesses focus on advancing in the innovation index, they will be forced to implement digital technologies. The next significant index in the context of our research is the Network Readiness Index including factors such as: technological component, human factor, management skills, Influence, each of the listed components also has a digital identification.

In the list of the most spoken about technological trends, more than half include digital technologies: unmanned taxi, portable devices measuring health status, e-houses (where artificial intelligence controls all household chores), neuro-interfaces (devices that directly connect your brain with a computer), personal adviser (a self-learning software—an artificial intelligence helping to make everyday decisions basing on a large data array), robot-surgeon, a humanlike robot-assistant, remote doctors (diagnostics and getting medical advice online), domestic 3D printers (to print any complex 3-dimentional objects), clothes made of "smart" nano-materials that can change its properties depending on the weather), portable devices of additional reality (for instance, glasses or lenses), implantable electronic microchips and mechanical devices (that can expand our intellectual and physical abilities), psychopharmacological remedies increasing brain power ("pills of genius"), robot-judges (following laws rigorously), implantable health sensors and many other.

From the above list of innovations, we can see that a significant portion of include digitalization and are also aimed at assisting humans and their needs, which actualizes the value of the concept of the "human factor of innovations." Separately, the research on social robots should be noted, which are the subject of close psychological and economic reflection. (Obaigbena *et al.*, 2024)

These are examples that offer us a glimpse of the profound changes – and associated risks – we are currently facing. Giddens (1990) used the image of the "Juggernaut of Modernity" to address the overwhelming effects of technical change over modern societies, one that provides unparalleled power and myriad possibilities, but which also often escapes our control. Convergingly, Beck's (1992) notion of "risk society" posits that technological progress, while a central aspect of modernization, generates new, systemic risks that are often unforeseen and frequently misinterpreted, thus often eluding traditional mechanisms of control and responsibility. Unlike pre-modern societies, where risks were primarily external and natural, contemporary societies produce self-inflicted hazards with global sensible effects.

This seemingly dichotomic nature of technology generates very distinct interpretations of the role of technology in society, leading to conceptual academic debates as well as very practical, policy issues. Competing narratives are shaped around different, yet incomplete, aspects of the complex dynamics surrounding technology, which tends to lead to equally incomplete, partial and fractured policy responses to sociotechnical challenges.

Behind the artifacts, infrastructures, and ideas that often ignored by politicians and businesses, and go unnoticed by the public, lie complex histories. As a result, we tend to understand technology as a product of strict technical decisions, which it certainly is not. And we fail to perceive fundamental elements that are part of the technology-society relationship. These elements shape the way we live, how we relate to each other, to the environment and to technology itself. And in a world full of things that we perceive as neutral, we often fail to realize how technological change and innovation operates, producing, for example, forms of control, surveillance, oppression or exclusion.

Moreover, the characteristics of things are rarely perceived as resulting from political dynamics and the explanation regarding the specificities of the configuration of artifacts and systems is usually referred to as "technical choices". This naturalizes the idea that technological development follows a single path, previously determined by the relevance of such choices. "Well, things are the way they are, and that's it. Why would they be different...?". There is an unshakable trust in "the one best way", the advancement of technology based on the fundamental values of efficiency, productivity, control, etc. which has oriented technological change and the development of innovations in modern times.

This very powerful idea also permeates our social imaginary, being profoundly embedded in the way we perceive sociotechnical dimensions and how we act in attempt to shape them and to regulate their outcomes, including through public policies.

Winner (2018) refers to innovation as the "god term" of our time. As he puts it,

> "A popular god term today has become an object of worship in universities, think tanks, corporations, Wall Street brokerage houses, and in the dreams of our social elites. The concept is widely associated with originality, vision, inventiveness, success, wealth, fame, personal virtue, national prosperity, and cultural vitality, and features are widely understood to express the aspirations and accomplishments of twenty-first-century societies at their very best. For many people, this concept has become the source of their deepest spiritual aspirations and yearnings for transcendence. In fact, it is not an exaggeration to say that today's central "god term" has begun to resemble a cult with ecstatic expectations, unquestioning loyalty, rites of veneration, and widely echoing exhortations of groupthink. The god term I have in mind is, of course, 'innovation' (p. 61-62)

This central notion serves as the background for the constitution of an overall positive view of innovation, widespread on our society, common among academics and certainly defining of the rationale from which science, technology and innovation policies are shaped, strikingly similarly although national contexts (and specific local problems) are very diverse.

It also serves as a buffer through which innovation is disconnected from its results, lest them be positive ones. If authors like Beck, Giddens and Winner, among many others, point out the complexity of sociotechnical dynamics, these ideas do not always reverberate. Godin stress the need to surpass what they have called the "pro-innovation bias", the idea that innovation always carry a positive effect to individuals and society. If not altogether ignored, its eventual negative effects are usually downplayed as either necessary, bearable externalities or as a natural consequence of change, to be latter regulated by adequate public policies and/or market mechanisms. Underlining this rationale there are certain psychological elements (which are, in turn, also shaped by them), also generally overlooked in analyses regarding the role of technological innovations in the contemporary world. The following section addresses this theme.

This perspective shifts the focus from "What do people think and feel about the innovation?" (and if the innovation is related to work, then what do employees feel about it) to "How does the impact of our innovation make society feel, and what are the psychological consequences of that?" Let's break down this expanded definition, its manifestations, and its weighty implications. This view defines human factors (social and psycho-

logical risks) as the potential for an innovation to cause harm to human dignity, social cohesion, cultural values, and individual well-being *at a societal level*, which in turn creates a profound sense of unease, moral injury, or existential threat among its creators, users, and the public. These risks manifest in several key ways:

A. SOCIETAL ANXIETY AND CULTURAL BACKLASH:

- Widespread public anxiety about genetic engineering ("playing God"), the potential for unintended consequences in the gene pool, and the emergence of a "genetic class divide." (Peters, 2014).
- Societal-level stress over economic displacement—the fear that robots and AI will make entire professions obsolete, leading to a loss of purpose and identity tied to work (Love, Smith and Dace, 2024).
- A collective sense of loss—the feeling that these platforms, designed to connect us, are actually designed to control people, they are eroding community bonds, shortening attention spans, and damaging the mental health of a generation (Haidt, 2024).

B. EROSION OF TRUST IN INSTITUTIONS:

- The psychological risk here is a collective shift from optimism to cynicism. When innovations from tech companies, financial institutions, or biotech firms are perceived as acting against the public interest, it breeds deep-seated distrust in all forms of authority and progress (Wolf, 2021).

C. ETHICAL DILEMMAS:

- AI features built to increase engagement are contributing to teen anxiety, political polarization, and the spread of misinformation and frauds. Digital innovations started influence cognitive and communicative abilities of children and numerous cases of addiction among audiences (Rohman *et al.*, 2025).
- Data scientists working on facial recognition technology who worry about its use in mass surveillance and the erosion of privacy (Payton, Claypoole, 2023).
- Designers in the gig economy creating systems that use psychological tricks to maximize productivity for drivers or delivery workers, leading to burnout and unsafe practices (Christie, Ward, 2019).

- The implications of ignoring *these* types of psychological risks are far more severe than a failed product launch. Businesses may face reputational catastrophe in the form of consumer boycotts, regulatory scrutiny and etc. The most significant implication is tangible harm: increased rates of depression and anxiety in the society, heightened social conflict, the destabilization of democracies, and increased economic inequality.

- Modern innovation is not just about technology and market fit; it's about socio-technical systems. In this light, managing psychological risks about protecting the society (and business) from the unintended consequences of progress. It is the essential work of ensuring that innovation remains a force for good.

2. THE PSYCHOLOGICAL CONTEXT OF INNOVATION

Each of the set of innovations we mentioned earlier, in the beginning of the former section, includes a set of elements: *Personality* and creative skills of creators, *a team* of specialists who strengthen each other, and *an Analysis* of the human factor of consumers' behavior (social factor, cultural factor, personal factor, technological factor, economical factor, etc.). At the same time, all these elements are in an environment that is characterized by its legal (institutional), ethno-cultural, religious features. Cultural factor is extremely diverse: religion (influence of religion, coverage, impact on people's actions, level of fatalism), history and art (reflect people's values and attitudes), means of communication (language, sign language, time, and punctuality), ethics and etiquette (acceptability, compatibility), living conditions (attitude to work, habits and organization of food, gifts, traditions in clothing and food consumption, features of leisure, housing, etc.), traditions of doing business (Zhou, 2021; Stephan, 2022).

In turn, the "ring" of the organization itself (departments, departments, sectors...) can also be multi-level. To some extent, we can look at this from the standpoint of W. Bronfenbrenner's theory of ecological systems (Bronfenbrenner, 1977). The value of this model may lie in the fact that it can consider a multi-level determination of perception or creation of innovations. Note that on the basis of this theory, another theory was developed that combines technologies and the social environment, which, in our opinion, has significant explanatory potential in the future (Navarro, Tudge, 2023). Its essence considers two environments (digital and pre-digital) as a single one with all the complexities of their perception. We also believe that the unification of the technological and the social in the

human psychological world is the dawn of new research in psychology, which includes and will increasingly include ethical and humanistic issues (Patrakov & Vodopyanova, 2024).

Based on this, let us consider the psychological aspects of innovation in more detail. Here we can distinguish two groups of studies. *The first group* is the methodology and empirics of attitudes towards new technologies (innovations). Fundamental research in the field of attitudes towards technology and global technological risks is based on the constructionist and interactionist paradigms, which are widely recognized in the cultural anthropology: construction of Artefacts by T. J. Pinch and V. Bijker (Pinch & Bijker, 2012); model of "Domestication" by R. Silverstone (Silverstone, 2006); Actor-Network theory of B. Latour (Latour, 1996); The Unified Theory of Acceptance and Use of New Technologies by V. Venkatesh (Venkatesh *et al.*, 2012). The essence of the indicated theories is in the understanding and psychological reflection of the diversity of factors that determine the attitude towards new technologies.

On the basis of these concepts, the authors of the current article have conducted a cross-cultural study on attitudes towards new technologies. The study confirmed the hypothesis that attitudes towards new technologies have cultural and age specifics. The results open up the prospects for discussing cross-cultural specifics of the attitudes towards technological innovations (Patrakov *et al.*, 2022).

Systematizing the listed concepts, Zhuravlev A.L., Nestik T.A (Zhuravlev & Nestik, 2019) proposed to consider the attitude towards new technologies in the following aspects: the cognitive aspect (continuum "techno-optimism – technopessimism"); emotional aspect (continuum "technophilia – technophobia"). Let's take for example social technophilia (excessive enthusiasm for technological innovations in society), which can potentially determine the formation of a stable attachment to technical means and innovations. An example of it is the regular updating of cell phones as soon as new models appear, although this updated functionality may not be in the list of essential demands and even not in the list of "nice-to-have". This "love for technology" has especially developed during the pandemic, which has "spurred" the literally uncontrolled growth of digitalization, associated with a number of psychological problems of an existential nature (Agnihotri & Shanker, 2023; Joshi *et al.*, 2021).

Thus, researchers note that new technologies cannot be considered as something separate from the life activities of subjects and communities. Today in psychological science we have a large number of studies on the risks of the Internet and digital environments for adolescents, raising the topic of not only obvious cyber addiction, but also the

ability to distinguish risks, differentiate them, and manage them (Núñez-Gómez *et al.*, 2021; Piko *et al.*, 2024). It should be noted that today almost all innovations include a digital component. Also, the main purchasers of innovative consumer products are young people who associate themselves with a promising future and are to some extent free from the values of conservatism (Stewart, 2022; Owen, von Schomberg *et al.*, 2021).

For example, examining technophobia and its causes in detail, we noticed that everything is not so simple. Various diagnostic methods assess the attitude towards new consumer technologies (social technophobia, technophilia, techno-rationalism, techno-pessimism). But they do not reveal their causes. For example, why is there a fear of new technologies? Based on research on teachers who showed a high level of technophobia on the Schwartz values scale (n=87), we found out the following: a high level of technophobia among teachers correlates with a high level of expression of "Tradition and Benevolence" ($r = 0.76$ at $p < 0.01$). We then conducted an additional study with focus groups on teachers (2 focus groups of 9 and 11 people), and included the following questions: (1) Why can new technologies (innovations) cause concern for some people? (2) What characterizes teachers who are afraid of new technologies?

The results showed the following: among the reasons why new technologies (innovations) may cause concern for some people, the first place was occupied by a possible contradiction with personal and social values. On the second question—what characterizes teachers who are afraid of new technologies—the most numerous reply was about the fear of a decrease in the quality of teaching. The overwhelming majority of teachers noted that maintaining a high level of professionalism in education was unthinkable without face-to-face communication with students, perceiving the digital environment only as a means, an assistance in success, but nothing more. In general, technopessimism implies not so much denial as a critical attitude towards new technologies; accordingly, it may indirectly indicate a fairly high professional reflexivity of respondents, which is also typical for teachers.

Digitalization entered the life space of both adults and children quickly and on a large scale. The current trends in the digital transformation of the living environment affected the formation not only of the personal sphere of the younger generation, but also of the cognitive one. The study showed that the field independence of both elementary school age students and middle school age students grows with each stage of digitalization, while the field independence of high school age students remains approximately at the same level at all stages of digitalization (Chernykh, 2023). Of course, it is difficult

to say for sure whether digitalization and innovation can be considered with a very clear distinction, since they are very closely intertwined. But the fact that innovations and digitalization change our behavior and cognitive sphere can be said with a high degree of probability.

There arises a necessity for a comprehensive examination and psychological description of the process, not merely of convergence, but of integration and merging of the digital and pre-digital environments. This represents a fundamentally new phenomenon, a novel realm of life activity that still has a high level of uncertainty. The evidence is that computer science is the fastest changing and evolving science, but it has an enormous impact on all other sciences as well. Therefore, today there is a need for a detailed study and psychological description of the process of not just convergence, but integration and merging of digital and pre-digital environments. This is a fundamentally new phenomenon, a new living environment, which is still characterized by a high level of uncertainty—a digital environment included in the promising, but sometimes foggy for science, space of innovation.

The second group of studies relates to the concept of "Augmented Human". In the context of interaction with innovations and digital environments, psychologists discuss a new aspect of personality development—the problem of forming an "extended personality" (Semenov, 2020) and the similar concept: "Augmented Human Intellect". This concept was proposed at the "dawn" of the development of computer technologies (Engelbart, 1962) and has a number of variants: "Extended self" (Belk, 2014), "Extended mind" (MacFarquhar, 2018). All of the listed definitions suggest that a person acquires new properties that go beyond his "natural" capabilities. But let us ask ourselves a question: does a person only acquire new opportunities, "expanded" properties, or are there any losses for humans? This is especially valid for the so-called social professions: teachers, psychologists, specialists in the field of social work and others. Is there a "psychological cost", and what is the price of such an expansion of the personality due to digital and innovative opportunities? Thus, we can see that innovations are very multidimensional, and their result can be very risky or even somewhat contradictory, including in terms of investment and results, for example, in digitalization (Hooi, Chan, 2024), which actualizes the value of risk research and personality.

3. ON THE IMPORTANCE OF RISKS RESEARCH IN THE CONTEXT OF INNOVATIONS

If innovation is intrinsically connected to the idea of change, risk research is essential in understanding the psychological dimensions of innovation, as it helps explain human resistance, acceptance, and adaptation to change. Through an integrative interdisciplinary approach, risk research examines how individuals perceive, evaluate, and respond to potential hazards associated with innovation. Individuals do not assess risks solely based on objective probability but rather through cognitive and emotional processes. Factors such as familiarity, perceived control, trust in institutions, and media representation shape individuals' risk perceptions. This complexity requires elements from different fields to be mobilized in order to promote a reasonable understanding of it.

Risk in its most general form (in economics, psychology and sociology) is consider-ed as a potential possibility of future losses due to a subjective decision or an unforeseen situation. For example, miscalculation is a subjective decision, and a natural disaster is an unforeseen situation (Fraser, Simkins, 2010). But still, there is a wide variety of concepts, approaches, classifications of risk understanding. In line with the *economic approach*, risk is understood as the financial or equivalent to financial damage. It is assumed that the value of risk can be measured, estimated, calculated. This approach is used in business, management, insurance, investment plan (Hardi *et al.*, 2024).

A political science approach to understanding risks is essentially similar to econo-mic approach, but it deals with a political damage and a more complex and often contradictory system of its assessment. In this approach, risk is mainly investigated from the point of view of political goals in the continuums: stability/ instability (social, economic), chaos/order (legality, civil obedience). This approach can be extended to the social policy of the enterprise, territory, including the policy of implementation and support of innovations (Deineka *et al.*, 2020).

In line with *the sociological approach* (Luhmann, 1994), the main subjects of the study of risks are the social situations and social relations that can generate such risks. For example, in the last decade, the phenomenon of attitudes towards new technologies (Nestik *et al.*, 2018) has been widely studied. In line with the study of such attitudes towards new technologies there is, for example, a pronounced social technophobia (fear of the general public to apply any technological innovations). Such technophobia, for example due to the cultural or other peculiarities can be a social risk factor for the introduction of innovations.

There are also quite a lot of studies related to digitalization and organizational change in the context of innovation. (Gurieva *et al.*, 2023; Zabelina, 2023). That is, the value and cultural foundations of such risks should also be taken into account here.

In addition, in general terms modern riskology distinguishes the following risk factors:

- the nature of the task (for example, an innovative task itself will be risky);
- situational influence (for example, the degree of openness of society in general or of individual social groups in particular, the institutional environment, including legislation);
- personal qualities of all participants of the interaction;
- the influence of intergroup interactions.

In addition, other research problems are also highlighted: risk motivation, subjective risk perception, situational risk regulation and etc. Anxiety, uncertainty, fears, optimism and expectations are often feelings that emerge when individuals have to deal with new technologies, and this, of course, tends to be dependent on social and cultural specificities as well. Large-scale transformations often elicit significant public discourse, reflecting broader anxieties about socioeconomic displacement, ethical considerations, and shifts in power structures, all of these aspects that should be taken into consideration as well.

Of course, research into the human factor of innovation is not limited to the approaches listed, but we believe that they all play a decisive role and should be more present in critical approaches to innovation as well as in policy-making strategies in science, technology and innovation policies.

4. REMODELING STI POLICIES BY ADDRESSING PSYCHOLOGICAL ASPECTS OF INNOVATION

The academic landscape of innovation comprises two interrelated domains:

1. **Innovation Studies (IS):** An interdisciplinary field investigating the genesis, diffusion, and utilization of innovation. Its analytical focus is on micro- and meso-level phenomena, including firm and startup behavior, scientific practice, and industrial network dynamics, to answer the question, "How and why do innovations occur?"

2. **Science, Technology, and Innovation Policy (STI Policy):** An applied field dedicated to the strategic guidance of innovation by governmental and institutional actors. It operates primarily at the macro-level, formulating national strategies, programs, fiscal incentives, and regulatory frameworks to address the question, "How can we stimulate innovation to address societal challenges?"

The synergy between these fields is fundamental. Innovation Studies constitutes the epistemological foundation for evidence-based policymaking, while STI Policy provides a context for implementation, offering both a testing ground and a source of new research questions and funding. Risk research may play a crucial role in informing and improving science, technology and innovation policies by providing insights into how individuals and societies perceive, evaluate, and respond to changes brought about by innovation. Innovation inherently involves uncertainty, so understanding the cognitive, emotional, and social dimensions of risk perception might provide an important strategy for decision makers and policy makers involved with STI policies. Innovation Research and STI Policy are fundamentally interdependent. Research generates the foundational understanding of how innovation works, while policy translates this knowledge into actionable strategies.

At both the project level (the focus of Research) and the strategic level (the focus of Policy), human factors are a critical variable. These psychological, sociological, and cultural elements can either facilitate or obstruct success. Therefore, integrating an understanding of these human dimensions is essential—not just to explain past failures, but to craft effective policies that are responsive to real-world social and behavioral dynamics.

A consistent body of literature has been developed around the theme of risks associated with emerging technologies in fields such as nanotechnologies (Invernizzi & Foladori, 2010; Grunwald, 2012), energy (Boudet, 2019; Markard *et al.*, 2020), health (Finch *et al.*, 2006), farming (Regan, 2019) and others. Risks associated with the evolution of Web 3.0 technologies now are arguably at the center of the debate (see Vayadande *et al.*, 2024).

The push for "Responsible Innovation" (Mcnaghten, 2020) and RRI—"Responsible Research and Innovation" (de Saille, 2015) has contributed to placing risk (and through it some of the psychological concerns regarding technology and innovation) in the agenda of STI policies. Important steps have been taken to address relevant policy questions and to improve policy effectiveness through a more comprehensive understanding of the social and psychological elements of technology and innovation.

How technological innovation is socially received (innovation acceptance) is a key aspect of dealing with the emergence of new technologies. By incorporating risk perception analysis into policy development, for instance, governments and regulatory bodies can address these concerns proactively through transparent communication, participatory decision-making, and tailored educational initiatives.

Furthermore, risk research provides empirical evidence to guide the regulation of emerging technologies. A risk-informed policy approach allows for a more balanced framework that mitigates potential negative consequences without hindering technological progress. Risk communication strategies are also an increasingly important element. By understanding how different social groups interpret risks and shape their behavior accordingly, policymakers can craft messages that resonate with specific audiences, reducing the spread and damage done by misinformation and fake news (a key challenge of our times) and fostering public engagement.

Despite their importance, these new elements in STI policymaking are still not able to cover all the necessary aspects to address the complex nature of technological change in society, people's lives and emotions. Indeed, saying this we are contributing to ongoing efforts to address the complex nature of technological change. We see the path proposed by RRI (although not everyone would agree with us) is a reformist approach to the policy model. And although RRI started from a critique of market innovation, its implementation has nevertheless become instrumental and too "technical". Focusing on this issue, A. Mohammadi (2021) proposes to increase awareness and responsibility of both developers and consumers of innovation by integrating the values of responsibility into scientific management systems, recognizing the merits of leading researchers and influential scientists in solving problems of society, the economy, and industry. In contrast, we initially advocate a more constructive approach to solving these problems that also takes into account people's perceptions, emotions and desires—aspects that are deeply affected by the high pace of innovation in the modern world.

5. RISK AND RESOURCES ANALYSIS MODEL

Thus, based on these studies, we have created a basic approach model for analyzing the risks and resources of innovation (Figure 1). The model includes three levels of analysis: the macro level (socio-cultural and institutional factors), the meso level (company level), and the micro level (a person as a subject, creator and/or consumer of innovations). Each

of these levels includes both risks and benefits. The risks comprise economic risks, social risks, and psychological risks (for the person). In turn, the benefits are expressed in the form of economic resources, social resources, and psychological resources.

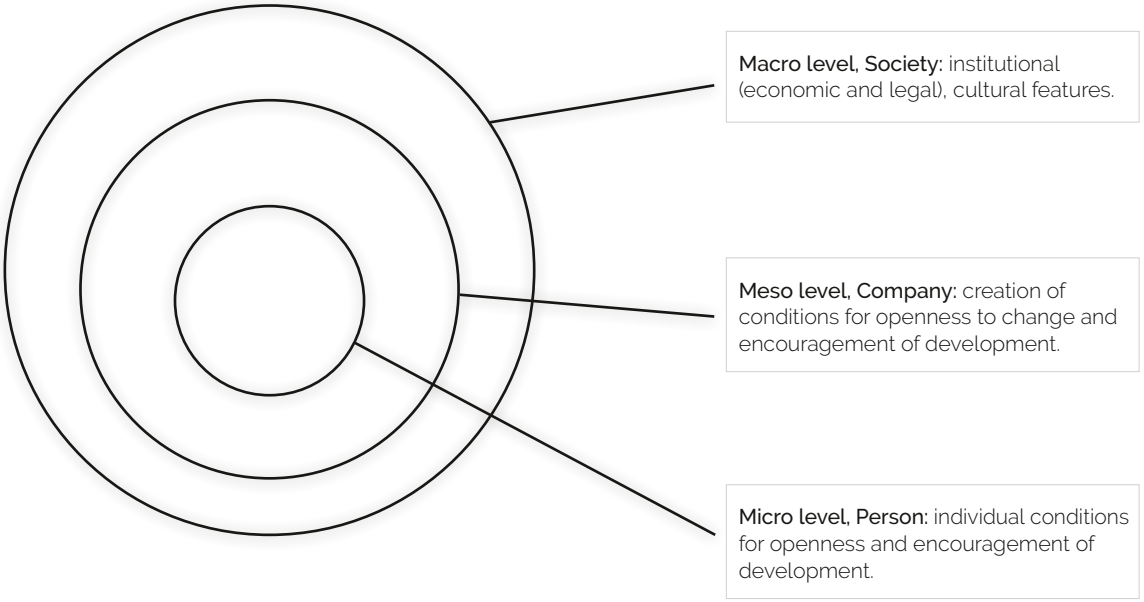

Figure 1. Risk and resources analysis model.
Source: own elaboration.

This figure indicates the following: the outer circle (society) is the environment that determines the main directions of innovation development and conditions. The outer circle includes cultural, economic, and legal features of society (as a rule, this is a country or a state). The second circle includes companies that plan to develop technological innovations. An important resource here is openness to innovation, a developing environment, and objective assessments. We consider the level of personality in two aspects, as a creator and as a consumer of innovations. Each factor can be considered as a risk and a resource depending on the idea of innovation.

This model is presented in more detail in Table 1.

Table 1. Content of Model.

Level	Specificity
Macro level	Culture
	Law
	Economics
Meso level	The purpose of the group
	Vocational roles and functions of the group members
	A way (methods) to solve problems
	Attitude to personality. Interpersonal relationships
	Open Innovation Climate
Micro level (creator of innovation)	A combination of creativity and erudition in the field of professional activity
Micro level The consumer (client)	Willingness/unwillingness to apply technological innovation

Source: own elaboration.

CONCLUDING REMARKS

Innovation is a central element of the way we currently understand our world. It is a topic that has been intensively addressed mostly by economic or social approaches, but less so through a psychological lens. This gap, as we believe, has somewhat been filled by risk research, although it has also been insufficient in covering all of the complex elements surrounding innovation. STI policies should take into account the psychological elements of innovation to a broader extent, placing individuals and society at the core of innovation dynamics, not only as actors that are affected by technological change, but as actors that should be heard in the shaping of innovation processes and dynamics. In this regard, we view our article as a contribution to the study of the psychological component of innovation studies and emphasize the following points.

Since innovations are included in the life of a person and in society as a whole, the need for their multidimensional measurement is obvious. Multidimensionality in our understanding means psychological, economic, social dimension, as well as depth of expression. Note that currently there are various innovation ratings, but there is a deficit of psychological and existential reflection of such innovations.

Innovations are characterized by a high degree of unpredictability, their development is not progressive, therefore, at different stages, the influence of various factors may weaken or increase. In these conditions, for forecasting, it is possible to activate factors from different resources. For example, in conditions of predicted social instability, the project team or simply a group of specialists involved in the implementation of an innovative project must have a high level of objectivity in decision-making, in labor behavior—the absence of deviations, socio-communicative adequacy and a number of other psychological characteristics.

Applicability in training the future innovators, engineers, psychologists, economists for the prevention of 'one-sided' understanding of the innovation process and learning to analyze the whole variety of factors that determine the development of innovation (primarily the human factor).

Dealing with innovations one needs to consider not only general risks but also cultural peculiarities, risks and opportunities connected to them. We cannot talk only about the risks of innovation, it would be more correct to talk about the continuum of 'risk-resource'. This is the main idea of our research. Many factors can be risks and resources depending on the idea of technological innovation.

In our opinion, it is impossible to describe all the factors of technological innovation development, but the proposed model can be considered as universal basic approach for evaluating technological innovation startups, analyzing the causes of success and failure.

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