DOCTORAL THESIS

Transition to Where? Exploring the Transformative Potential of “Cosmolocal Technology” in Quest of Future Coexistence

Asimina Kouvara

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Declaration:
Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for doctoral or equivalent academic degree.

Asimina Kouvara

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Üleminekud kuhu?
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ASIMINA KOUVARA

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List of Publications

The list of author's publications, on the basis of which the thesis has been prepared:

I. **Kouvara, A.**, Priavolou, C., Ott, D., Scherer, P., & van Zyl-Bulitta, V.H. (2023). Circular, Local, Open: A Recipe for Sustainable Building Construction. *Buildings*, *13*(10), 2493. **ETIS 1.1.**

II. **Kouvara, A.** (2024). Beyond fraudulent hopes versus despair: The potential of commons-based technological futures. *Journal of Futures Studies, 29*(2), 59−72. **ETIS 1.1.**

III. Kostakis, V., Parker, M., & **Kouvara, A.** (2025). A tunnel to the other side of the world: What sort of writing can contribute to social change? *Culture & Organization.* **ETIS 1.1.**

IV. Kostakis, V., Lemos, L., & **Kouvara, A.** (2024). Another scalability is possible! From non-scalability to cosmolocal scalability. t*ripleC, 22*(2), 620−629*.* **ETIS 1.1.**

V. Pisith, S, & **Kouvara, A.** (forthcoming). A Look at the Commons through the Lens of Buddhist Ethics. In: Stefan Partelow (Ed.). *Ethics and the Commons: Navigating the Normative and Applied Issues of Governance*. Center for Life Ethics at the University of Bonn Series. Springer. **ETIS 3.1.**

VI. Sklavounos, I., Kostoulas, P., Koutropoulos, G., **Kouvara, M.**, & Theocharis, C. (2020). Kalderimi X2, Tzoumerka, Epirus: Paving the way for a new generation of craftspeople. *Journal of Traditional Building Architecture and Urbanism*, *1*, 100−111. **ETIS 1.2.**

Author's Contribution to the Publications

Contribution to the papers in this thesis are:

I. The author of this thesis established the theoretical framework in collaboration with the paper's second author. The thesis author was also responsible for conducting interviews, gathering and analysing qualitative data from the case study, and was involved in the conceptualisation, visualisation, writing, and editing the original manuscript. As the first author, she managed primary correspondence and revisions of the manuscript.

II. The thesis author developed the conceptual framework, conducted and documented the case study, and gathered and analysed qualitative field data. As the sole author, she prepared the manuscript, made revisions, and handled all correspondence.

III. The author of the thesis contributed to the revision of the original manuscript by proposing a new conceptual framework and conducting a literature review concerning cross-writing approaches for communicating academic research to diverse audiences. The thesis author was involved in writing and editing throughout the peer-review process.

IV. The thesis author conducted a targeted literature review to enrich the argument of the reflection paper and contributed to editing the original manuscript.

V. The thesis author contributed to the sections regarding the theory of the commons and to the chapter's structure. The author was also involved in writing, editing, and revising the manuscript.

VI. The author of this thesis contributed to documenting the project outlined in the paper, participated in fieldwork, and carried out hands-on research as a co-founder, participant, and researcher in the initiative presented in the manuscript.

Preface

One morning this summer, I woke up to the news that fish experience side effects from Prozac (antidepressants) due to urban waterways being contaminated by the increasing consumption of such pharmaceuticals[1]. At first, I found it hard to process, yet I was not surprised. We are now living in 2025, and "They live" too, as John Carpenter accurately predicted in his 1988 sci-fi film. Similarly, Orwell foresaw that "Big Brother is watching you" in his book "1984," written in 1949, and so forth. Art continues to prove how much more effectively it can predict the future than complex, data-informed models. Yet, for some reason, we forget the power of imagination, and the power of greed, confining our efforts exclusively to numbers.

Despite many years of schooling, I have an inherent inability to comprehend this established "common sense" and to rationalise what is deemed rational. However, this issue is certainly not only a problem of mine. My ongoing frustration of "not understanding" has driven me towards a journey to explore technologies and practices of the past, aiming to uncover what else exists and why the tacit knowledge and ingenuity, the vernacular wisdom, reflected in pre-industrial technologies, has been forsaken or replaced, often regarded as a sign of backwardness. Could this wisdom be restored, reclaimed, recuperated, reappropriated, or reinvented?

Initially, I was keen to learn about traditional architecture and building techniques. Throughout this journey, my interests expanded to include textile making, agriculture, and traditional Chinese health practices[2]. I have been exploring these fields as a practitioner, researcher, and participant in various initiatives, workshops, and training. However, when I later joined the "COSMOLOCALISM" research project[3], my investigation widened to encompass a broader inquiry into technology. I then began to wonder whether a contemporary technological trajectory that evolves in pace and rhythm, within the limits of the physical world and in harmony with multiple perceptions of nature and the cosmos, might be possible.

This is what this thesis aims to explore.

1 https://www.theguardian.com/environment/article/2024/aug/27/australia-prozac-waterways-fish-behaviour

2 I practice/study Wudang martial arts, Guqin (the ancient Chinese zither), and traditional Chinese medicine.

3 https://www.cosmolocalism.eu/

Introduction

Despite abundant information about the damage caused by the dominant techno-economic trajectory, why is not enough change happening (Paulson, 2017)? And why, despite global sustainability efforts launched nearly four decades ago, does the "developed" world still adhere to loops of unsustainable choices (Sabau, 2020)? Have people become so accustomed to the belief that transformative change is impossible, or is there something else that provokes social stagnation amidst the destruction? Will technology save us all in the end?

The detrimental effects of the current trajectory-driven by relentless economic growth, industrial-scale production, unprecedented technological acceleration, and the assumed hegemony of the Western mind-exist, persist, and intensify despite being veiled, ignored, or denied. This trajectory is underpinned by an unfounded techno-optimism – a belief that modern technology can save humanity from looming catastrophes, avert the damage itself creates, and even liberate us from the constraints of human finitude. This belief holds some truth but not the whole truth. Even a simple children's story can illustrate the grim reality of perpetuating social injustices and environmental degradation inherent in the current predicament (**III**). Yet there is considerable resistance against looking straight into the trouble, let alone staying with it (Haraway, 2016).

Part of the answer to why not enough change is happening lies in dominant institutions determining which worldview, and what morals and motives drive change, who is included or excluded from decision-making, what information is widely disseminated or withheld, how knowledge is produced, and which methods, narratives and pathways forward are prioritised (Saltelli et al., 2020; Silva & Stocker, 2018; Voci & Karmasin, 2024; **I**; **II**; **III**; **IV**). It also involves reflecting on the mechanisms available to society to confront unsettling realities or to envision and pursue alternative possibilities (**II**; **III**). I assume another dimension of the answer resides in the philosophical and psychological spheres, questioning what it means to be human and how we relate to "this strange being called the cosmos" (Hui, 2022b)[4].

My aim is not to provide definitive answers to such questions but to inspire debate about the role of technology in driving transitions and transformations towards sustainable futures, challenging its current entanglement with reductionist and corporate-favoured ideas. I am troubled by the fact that much "uncomfortable knowledge" (Rayner, 2012) remains absent from discussions on sustainability, despite the growing recognition of the dark side of modern technology.

I view "technology" as integral to the human condition, a materialisation of worldviews (Hui, 2017a), and as an ambivalent (Feenberg, 1990) transformative force-capable of either leading to deepening crises and human domination or aiding the pursuit of healthier, just, *truly* sustainable futures for all. In this light, "modern technology" here represents a specific perception of "technology" based on Western modern ideals and dualist thought. Additionally, I consider the concepts of "sustainability" and

4 "*Cosmos* is a Greek word for the order of the universe. It is, in a way, the opposite of *Chaos*. It implies the deep interconnectedness of all things. […] We seek a connection with the Cosmos. We want to count in the grand scale of things. And it turns out we *are* connected not in the personal, small scale unimaginative fashion that the astrologers pretend, but in the deepest ways, involving the origin of matter, the habitability of the Earth, the evolution and destiny of the human species, themes to which we will return." (Sagan, 1980).

"sustainability transitions" to involve a double hermeneutic (Audet, 2014) and view them as open to various interpretations.

Like many others, I find it difficult to understand how further efforts along the current path could lead to the second (hopefully) desired future scenario, which, for now, remains both elusive and contested. If I were to describe it in a few words, this future would be guided by *planetary thinking* – an understanding that our current situation extends beyond the configuration of modern nation-states, anthropocentrism, and a Eurocentric view of history (Hui, 2024; 2021; 2019). It would be founded on *relationality*, where relationships among humans and non-humans are perceived as inherent and reciprocal – mutually interdependent and framed by the broader cosmic order; where living, social, technical, spiritual, and knowledge realms encompass one another, a quality reflected in the tangible outcomes of these relationships – *technics* (e.g., governance, tools) (Hui, 2017a; 2022a). Their interrelations would be presupposed rather than externally imposed to manage their interaction. "Nothing preexists the relations that constitute it" (Escobar et al., 2024, p. 8). This understanding of relationality contrasts with the reductionist techno-managerial perspectives on sustainability, which commence from an assumed division between humans and "nature" (a particular interpretation of nature) and then attempt to control how one affects the other, already implying an inherent conflict. Furthermore, it would be a future of *coexistence*, where diversity is embraced rather than merely tolerated (Hui, 2024), allowing different peoples and species to thrive on the same planet without depleting it, with each having a fair share and voice in fostering their prosperity (Bollier, 2024).

Such a future may seem distant, if not entirely unattainable, and is hard to imagine when confronted with the violent history of "civilisation" – scarred by genocides, ecocides, and apartheids of sorts. Its pursuit likely becomes more complicated due to our inherently limited or dispossessed ability to grapple with our subconscious awareness of mortality and the vulnerability of our earthly condition (Simpson, 2024).

The ways in which the Western mind conceives of human existence and coexistence are reflected in its cultural, social, political, economic, and technological systems – which, in their most extreme manifestations, render even metaphors seemingly redundant to describe. It is a world where ideals defining what it is to be human are lowered so much that the "highest" are reduced to material wealth, power, and virtual recognition, the relentless becoming of a self-absorbed, successful individual. It is a rootless culture, where the fear of dying (or living) is diverted into becoming a consumer and a commodity, always striving to be consistently happy, productive, and optimistic – while veiling hopelessness (Žižek, 2018); ultimately failing to "beat death in life" (Bukowski, 1996). It is a society of isolated atoms (Hui & Halpin, 2013), superficially connected through transactional networks yet disconnected from one another and the planet we depend upon (Escobar et al., 2024); a status quo of authoritarian "democracies" and state-corporation alliances (Klein, 2007) exploiting others' struggle for survival under the guise of progress (Barca, 2020); whilst building walls and sophisticated systems to "protect nature" from us, and secure us from natural disasters, and invisible threats – free-riders, terrorists, refugees, or "the woke virus" of the mind[5]. Yet, who genuinely feels secure or content in such a world?

Nevertheless, another facet of human civilisation exists, primarily linked to the past yet carrying the seeds to a desired future (Kallis & March, 2015). It is reflected in a vast

5 https://www.theguardian.com/us-news/2022/dec/20/anti-woke-race-america-history

array of ancient texts, indigenous mythologies, and more recent imaginaries and practices through which human vulnerability is rationalised and materialised in *vernacular*[6] ways of being, living, creating, and knowing that significantly differ from the established ones (Illich, 1980). This variety encompasses a range of common senses (Muñoz-Sueiro & Kallis, 2024) and commoning practices (Bollier & Helfrich, 2019; Ostrom, 1990), epistemes and epistemologies (Santos, 2015), systems of governance and public administration (Chafik & Drechsler, 2022; Drechsler, 2015; Shakya & Drechsler, 2023; **V**), and technologies (Hui, 2022a; **VI**), some of which remain relatable and relevant across cultures, localities, and time, or (re-)emerging.

The flattening forces of modernity and capitalist expansion, though, have overshadowed this diversity, with a determining role played by technological globalisation (Hui, 2024; Tsing, 2012; 2015; **IV**) rooted in a perception of technology as anthropologically universal (Hui, 2017b).

The growing awareness of various pressing issues associated with industrial capitalism and modern technology (e.g., environmental degradation, global wealth inequality, and cultural homogenisation), highlighted by the emergence of contested concepts like the Anthropocene, Plantationocene, or Capitalocene (Haraway, 2015), signals a transition beyond the so-called unconsciousness of modernity (Hui, 2022a). However, to leverage this shift towards a desired future requires more than mere recognition or critique. One of the most urgent imperatives is an in-depth inquiry into technology (Hui, 2017a).

First, this inquiry is essential to illuminate the overshadowed implications of modern technology and challenge its dominant role in shaping current sustainability discourses and courses of action (Takkinen & Heikkurinen, 2024). Second, it is crucial to explore alternative pathways for technology that could enable the flourishing of different imaginaries (Hui, 2024).

Proponents of the dominant politico-economic arrangements may acknowledge the evident problems but still argue that solutions lie in technological advancement (Hickel & Kallis, 2020; **II**; **III**). They typically focus on decoupling economic growth from environmental impacts while suggesting techno-managerial interventions to mitigate the disruptions caused by emerging technologies (Biely & Chakori, 2024). These perspectives bypass profound implications of modern technology (particularly affecting communities in the Global South) (Sovacool et al., 2020), simplify the "wicked" nature of sustainability challenges (Brown et al., 2010), and certainly do not question the very onto-political foundations of their strategies.

Conversely, proponents of alternative imaginaries and configurations critique the hegemony of Western modern, growth-oriented, and excessively technocratic approaches to prosperity, progress, and sustainability (e.g., Escobar, 2015). They highlight issues of

6 I employ the term "vernacular" as defined by Ivan Illich (1980) to describe autonomous, non-market-related practices that inherently evade bureaucratic control and through which people satisfy needs. These practices promote conditions of sufficiency and subsistence, founded on symbiotic relationships with natural ecosystems. Such reciprocal practices extend beyond monetary value, resisting the commodification, enclosure, and exploitation of shared resources and spirituality, while nurturing cooperative, convivial, grassroots forms of organisation, governance, and production (Galan et al., 2020; Illich, 1973; 1980; Schroyer, 2009). Illich transcends the mere association of these practices with the past, suggesting that the vernacular mode of being, doing, and making can once again expand in every aspect of life within a desirable (sustainable) future society (Illich, 1980). In this regard, it could encompass both pre-modern practices and digital cooperative networks equally.

power politics and justice that remain largely unaddressed or disturbingly silenced, and envision different pathways forward. However, they tend to avoid the question of technology, which is, nonetheless, unavoidable in the face of the contemporary planetary condition (Hui, 2024).

In this context, I explore an emerging mode of production and technology development rooted in the commons, namely "cosmolocal production" – referred to here as "cosmolocal technology". My aim is to enrich our understanding of this phenomenon and investigate its transformative potential amid ongoing crises. I view cosmolocal technology as a holistic (though not perfect) practical response to the overlooked question of technology, one that aligns with several alternative transition discourses. Through a cosmo/onto-logical reading, I examine critical but under-explored dimensions that could enhance its potential for meaningful change. To support this analysis, I employ "cosmotechnics" as a philosophical framework, expanding the inquiry beyond political, economic, and ecological considerations.

In this regard, my central question is: What is, or what could be, the transformative potential of cosmolocal technology in pursuing sustainable futures? Additionally, I explore secondary questions to uncover various dimensions of the main inquiry, including: What aspects of mainstream approaches (e.g., narratives, methods) to sustainability and technology hinder effective transitions, and how does cosmolocal technology address these limitations (**I**; **II**; **III**; **IV**)? How does cosmolocal technology challenge the "scale-at-all-costs" mentality and the "one-size-fits-all" solutions (**II**; **IV**)? How do commons-based institutions foster collective, transformative action, and how can this mobilising potential be communicated effectively beyond academia (**II**; **III**)?

The thesis draws on insights from four original publications and prior research on cosmolocal production, utilising additional key theoretical elements to present a new threefold contribution in its own right: First, it bridges grounded research on cosmolocal production to a broader horizon of inquiry in the context of planetary challenges. Second, it strengthens the connection of the cosmolocal framework with pertinent alternative discourses on transitions and transformations. Third, it positions cosmolocal technology as a framework that could facilitate collective action towards a common vision for a future rooted in alternative socio-political formations but also in the "relational dimension of life" (Escobar, 2018, p. 8).

The exploration unfolds gradually through a theoretical overview that elucidates critical aspects of the current techno-economic predicament and highlights how alternative perspectives challenge prevailing understandings of sustainability and technology, advocating for different future pathways. Anchored on these perspectives, the thesis ultimately discusses distinct aspects that underscore the transformative potential of cosmolocal technology. Some findings are supported by empirical evidence, while others embody theoretical ideas that aim to open new avenues for research and dialogue.

In essence, I maintain that the potential of cosmolocal technology resides in providing the infrastructure for grassroots re-appropriation of modern technology for collective benefit; in transcending stagnating dichotomies that dominate debates on technology and transitions, paving the way for the re-emergence of techno-diversity and grassroots technological autonomy; and in fostering cross-pollination and exchange between alternative discourse empowering the possibility of substantial changes towards a future of planetary coexistence.

The remainder of the thesis is organised as follows: the next section provides an overview of cosmolocal technology and the commons. Section 2 details the methodological approach. Section 3 outlines the theoretical background, and foregrounds critical observations. Section 4 presents the key findings of this exploration, addressing the principal research question. Finally, Section 5 offers concluding remarks, discusses limitations, and suggests avenues for future research.

1 “Cosmolocal Technology” and the Commons

“Cosmolocal technology” arises within the innovative structural framework known as “cosmolocalism” or “cosmolocal production.” This framework is based on the commons and combines global knowledge exchange with localised manufacturing, facilitated by digital communication networks (Kostakis et al., 2023a; Schismenos et al., 2020; **II**; **III**; **IV**).

The commons, as defined here, are not merely resources or resource management schemes, as suggested by capitalist-aligned and mechanistic approaches (Bollier, 2024). Instead, they represent a mode of social organisation that empowers communities to collaboratively manage shared resources and produce goods while prioritising socio-ecological well-being, placing an emphasis on access, transparency, and fairness (Bollier, 2014; Bollier & Helfrich, 2019). As such, the commons encompasses a rich diversity of examples throughout history and across localities and cultures, from community forests and fisheries to digital communities and emerging cosmolocal initiatives (Bauwens et al., 2019; Bollier, 2024; Ostrom, 1990; 2009). Nevertheless, there are no universal models or blueprints to define exactly how such commons-based ventures should be created and operated. Each example is unique (Bollier & Helfrich, 2019). In this way, the commons can be seen as a universal language unbounded by universalist ideologies (Gibson-Graham, 2002).

Viewing the commons as a social system highlights the dynamic complexities and symbiotic relationships among commoners, akin to all living systems (Bollier, 2024). Contrary to the orthodox economics’ assumption that people are inherently driven by individualistic self-interest – necessitating private or state ownership and regulatory frameworks to prevent resource depletion (Hardin, 1968) – commoners align their self-interest with the collective (**V**). They operate with a non-competitive mindset, asserting a degree of self-determination in fulfilling their needs directly and independently of markets and centralised state control (Bollier, 2024; Feola & Jaworska, 2019). Though the commons often operate as a “shadow culture” barely acknowledged by official institutions (Bartels, 2024; Bollier, 2024) and largely neglected by numerous disciplines (including sustainability sciences, and sustainability transitions) (Swilling, 2019; **III**) – continue to challenge the dominant trajectory beyond critique, illustrating how alternative forms of living, making, and making sense can navigate and shape sustainability transitions.

Commoners embrace interdependence with one another, with natural systems, and with non-human beings, not as a constraint but as the foundation for fostering prosperity. Their reciprocal relationships are rooted in ethics of care, mutual trust, and a sense of togetherness (Mandalaki & Fotaki, 2020). In this light, communing – the act of contributing to and benefiting from the commons – can be understood as “relationality in practice” (Swilling, 2019).

In the context of cosmolocal technology, commoners are empowered to utilise a globally shared pool of knowledge resources, including design files, skills, good practices, and know-how, openly available as digital commons to produce technologies; and contribute new solutions or refine existing ones. Physical production occurs locally, utilising shared infrastructures like makerspaces and fab labs, and is informed by demand and regional biophysical conditions, ideally aligning with the value systems defined by participants (Kostakis et al., 2018).

At present, several initiatives, primarily from the Global North, utilise the cosmolocal framework to develop a range of open-source solutions, including agricultural technologies

(e.g., L'Atelier Paysan, Tzoumakers) (**II**), prosthetics (e.g., OpenBionics), renewable energy systems (e.g., Wind Empowerment), buildings (WikiHouse), and even space technologies (e.g., Libre Space Foundation). Such initiatives can also be regarded as part of a distinct category of social movements, which Hess (2005) describes as technology- and product-oriented (**II**). Instead of merely critiquing or opposing the status quo of industrial production, these movements illustrate alternatives in practice (Giotitsas, 2019).

Cosmolocal technology promotes design-embedded sustainability, transparency and openness, countering planned obsolescence and enabling well-informed life-cycle sustainability assessments (Kostakis et al., 2018; 2023a). It also fosters *conviviality*[7] as an alternative to industrialism, emphasising the importance of social autonomy in technology production (Illich, 1973; Kostakis & Tsiouris, 2024). Additionally, it embraces the concept of "mid-tech" to achieve a balanced synthesis of high and low technologies (Kostakis et al., 2023b). The mid-tech approach combines high-tech efficiency with the autonomy and resilience of low-tech alternatives, utilising advanced digital design and knowledge-sharing tools while incorporating local expertise and simple techniques (Kostakis et al., 2023b). Lastly, cosmolocal technology offers a different perspective on scalability, where projects grow through global knowledge networks of small-scale, locally-oriented communities, challenging the idea of up-scaling at any cost (**IV**).

Consequently, local communities are empowered to design and produce durable, repairable, affordable, and contextually appropriate technologies that are tailored – or adaptable – to regional needs, capacities, available resources, and cultural specificities, while being supported by and contributing to a global knowledge community (Kostakis & Tsiouris, 2024).

In these ways, cosmolocal technology seeks to minimise material and energy footprints, reduce dependence on global value chains and proprietary technologies, and foster local autonomy, subsistence, and bio-cultural diversity. Nevertheless, several challenges remain, including reliance on energy-intensive digital infrastructures, limitations in the licensing and standardisation of open-source solutions, and insufficient institutional support (Costanza-Chock, 2020; Kostakis, 2019).

In spite of these obstacles, cosmolocal technology offers a promising alternative to the dominant model of centralised, proprietary technological development. Rooted in a cooperative and relational ethos, the continuous emergence of technology-oriented commons-based ventures demonstrates in practice how technology could be understood, developed and deployed differently, prefiguring an alternative vision of the future.

7 Conviviality is associated with a vision of a society where tools and institutions serve users rather than create dependency. It represents an intrinsic ethical value of production modes that allow people to meet their needs autonomously through social solidarity, friendship, and mutual exchange (see Illich, 1973; Vetter, 2018).

2 Methodological approach

This thesis presents the findings of an exploration into the transformative potential of cosmolocal technology in sustainability transitions. Adopting an exploratory and interpretivist approach to understanding this emerging phenomenon (Stebbins, 2001), the investigation is informed by the perspectives of communities engaged in cosmolocal technology and by my positionality as a hands-on researcher, practitioner, and participant in relevant projects.

The thesis builds on three original peer-reviewed articles and one reflection article (ETIS 1.1) (**I**; **II**; **III**; **IV**) (Appendix 1), alongside prior research on cosmolocalism conducted within the "COSMOLOCALISM" research project. It also incorporates insights from a book chapter (ETIS 3.1) (**V**) and another journal article (ETIS 1.2) (**VI**), although these are not central to the thesis (Appendix 2). In this final manuscript, I further integrate new theoretical perspectives to comprehensively address the research question. The overarching theme of the publications is to identify areas of critique and limitations within established notions, practices, and discourses regarding technology and sustainable futures, while tracing key attributes of cosmolocal technology that emerge as essential to its transformative potential for sustainability transitions.

The publications utilise qualitative methods and theoretical/conceptual analyses to elucidate various aspects of the inquiry. Publications **I** and **II** include illustrative case studies that provide real-world insights. The first case details an initiative developing an eco-friendly building construction system, adhering to a more conventional business approach to sustainable production, which reveals key points of both convergence and divergence with the cosmolocal approach (**I**). The second case discusses a grassroots initiative that develops open-source agricultural technologies, which also served as a pilot case for the "COSMOLOCALISM" research project, offering insights into cosmolocal technology development studied in its original setting (**II**). Publications **III** and **IV** present analyses from distinct theoretical perspectives, addressing more specific aspects of the thesis's inquiry, such as communicating alternative trajectories like cosmolocalism (**III**) and employing a different approach to scalability (**IV**).

Furthermore, Publication **I** employs a quantitative Life-Cycle Assessment (LCA) method to evaluate the environmental sustainability of the building system developed by the initiative. This method was used to assess the building system's footprint, but within the context of this publication, it serves as an opportunity to engage in a critical discussion about the assessment method itself.

The data were gathered from various sources, comprising semi-structured interviews (**I**), field research and participant observation (**II**), desk research of online internal documentation, and outreach related to the cases examined (**I**; **II**), outcomes of the LCA analysis (**I**), and the authors' personal experience (**II**; **III**). A literature review, conceptual analysis, and critical reflections from the authors' grounded perspectives guided the more theoretical pieces (**II**; **III**; **IV**).

The thesis draws from a diverse range of fields – including Transition Studies, Futures Studies, Science, Technology and Society (STS), Philosophy of Technology, and Sustainability Studies – interweaving theoretical frameworks that converge around a critique of the dominant paradigm and advocate for the development of new concepts, frameworks, institutions, and methods to rethink, develop, and communicate alternative trajectories as a holistic response to sustainability challenges. Additionally, the thesis is inspired by approaches to conducting and writing research that emphasise the inclusion

of diverse epistemologies, such as indigenous knowledge and non-Western thought, as well as subjective viewpoints which challenge the narrow lens of traditional sustainability transition studies (Escobar et al., 2024; Hui, 2024; Santos, 2015) and prevailing academic research/writing conventions (Gilmore et al., 2019; Weatherall, 2023). This theoretical diversity has enabled a multifaceted exploration of the research question, enhancing my understanding of cosmolocal technology while also allowing me to introduce cosmolocalism into various emerging discourses, thereby laying the foundation for future research and action.

1.2 Writing approach: In defence of writing (a bit) differently

My thesis occasionally adopts an evocative, graphic, and personal writing tone in an effort to write (a bit) differently and subjectively while acknowledging the inherent biases present in my work. This personal and creative approach feels more intrinsically aligned with the nature and scope of my research. Such a writing style may seem unfamiliar compared to traditional academic approaches, yet it resonates more with the scholarship engaging with alternative visions for the future. The latter is where I stand.

The aim of "writing differently" (Gilmore et al., 2019) here is to communicate directly with the person behind the reader, to establish a genuine connection, and to spark dialogue and imagination about alternative future possibilities. Direct communication inherently involves emotions and subjectivity, and within the context of this thesis, it requires a clear positioning within the current power struggles to enable a fruitful and honest dialogue.

Academic norms often disregard personal knowledge, embodied experience, self-exposure, and creative writing styles are often disregarded by academic norms, which predominantly privilege expert knowledge and impersonal writing conventions, seemingly guided by objectivity (Wall, 2006; **I**; **III**). However, this perspective is evolving as scholars seek to transcend constraints that frequently exclude alternative ways of being and knowing in favour of abstraction and cognition (O'Shea, 2019; Pullen et al., 2020; **III**). Further, scholars increasingly explore how scientific research can become more heterogeneous, reflexive, and socially accountable (Rau et al., 2018). In this direction, they investigate "how a different, more inclusive politics and ethics could be developed and shared through academic writing" (Weatherall, 2023, p. 515) and seek ways to communicate beyond academic circles, journal paywalls, and the void of digital repositories. Such a shift is particularly crucial for emerging transformative phenomena like cosmolocalism, and is deeply relevant to critical debates on enhancing the integrity and social relevance of research on sustainability, technology, and transition (Audet, 2014; Feola & Jaworska, 2019; Rau et al., 2018; Takkinen & Heikkurinen, 2024; **III**).

Therefore, my choice to write differently – interweaving personal expression with works that have significantly influenced my thinking – represents a modest act of creative resistance against established conventions. Most importantly, it hints at an attempt to reclaim academic writing as a living, breathing medium that can inspire collective action toward a brighter future.

3 Sustainability, technology and transitions/transformations

The expanding body of work known as "transition studies" includes a range of theories and discourses that, within the context of sustainability, uncover two distinct schools of thought (Swilling, 2019). The principal difference between them lies in how they engage with the politics and ontologies underpinning sustainability, transitions, and transformations, and how they envision a desired future.

The concepts of "transition" and "transformation" have become buzzwords in political, scientific, and social movements (Audet, 2014), often used interchangeably and metaphorically (Hölscher et al., 2018). Despite the varied interpretations among different actors, the primary message conveys a desire to transcend the current (unsustainable) state of affairs and to identify pathways and solutions that would facilitate change in the pursuit of a renewed (sustainable) society, in harmony with the natural environment (Silva & Stocker, 2018).

Nonetheless, these concepts are value-laden, reflecting the perceptions, worldviews, and cognition of the relevant actors. Therefore, the context of change depends on whose agency is included or excluded from discussions and decisions (Patterson et al., 2016). Consequently, the processes that shape transitions and transformations are inherently political (Hölscher et al., 2018). Furthermore, despite all actors aspiring for a collective shift towards sustainability, the nature of this shift and the envisioned future remain debatable and contested. As Audet (2014) argues, these concepts embody a double hermeneutic. In the case of social movements that question the politics at play, the loose conceptualisations may offer a broad foundation for agreement and inspiration (Audet, 2014). However, the conceptual ambiguity, particularly surrounding transformational change, may undermine the contributions of these movements in challenging the status quo (Hölscher et al., 2018).

The first school examines transitions through the lens of sustainability transitions theory, developed in academia, exploring transformative changes through multiple dimensions (e.g., socio-technical, socio-ecological, and socio-institutional) (Grin et al., 2010; Loorbach et al., 2017). This approach primarily encompasses technical and managerial solutions, while failing (or avoiding) to address the power dynamics and ontological assumptions that fundamentally shape transformation processes (Biely & Chakori, 2024). These techno-managerial approaches predominantly operate within the framework of "greening" the growth economy, positioning advanced technologies as key enablers of sustainability (Hickel & Kallis, 2020). Consequently, sustainability is reduced to a technical issue, with techno-scientific controllability viewed as crucial for addressing mounting environmental challenges (Stirling, 2023, as cited in Takkinen & Heikkurinen 2024).

The second school encompasses discourses that primarily arise from social movements and activist action, concentrating on the political and cultural/ontological dimensions of transitions/transformations. These discourses advocate for radical transformations of dominant institutions and practices (Escobar, 2015). This perspective largely critiques the model of neoliberal globalisation and envisions futures beyond growth, development, and extractivism (Swilling, 2019). However, these alternative visions frequently encounter criticism for lacking concrete pathways to implement fundamental changes, including questions of agency in driving such transformations (Swilling, 2019).

As a researcher and practitioner committed to such an alternative vision, I partially acknowledge this critique – and it is precisely what this thesis aims to explore: a practical

and potentially transformative response in the making. However, I question the validity of this critique when it arises from standpoints that overlook or disregard two fundamental barriers: namely, the formidable resistance posed by dominant institutions and the epistemological hegemony of Western techno-science (Hui, 2024; Santos, 2015). These systemic constraints actively and systematically undermine the potential for alternative possibilities. I emphasise, however, Hui's (2024) argument that such alternative proposals risk fading into obscurity or being co-opted by existing power structures if the question of technology is not rigorously and strategically addressed.

Following, I will first provide an overview of how sustainability and modern technology are predominantly framed and assessed. This overview aims to highlight critical issues that traditional transition discourses overlook or, conversely, that underpin critiques. Subsequently, I will examine alternative approaches to thinking sustainability, technology, and transitions/transformations.

3.1 The narrow lens of traditional sustainability transition discourses

3.1.1 The problem with "sustainability"

Awareness of environmental degradation caused by human activity and its impact on societal well-being has deep historical roots that trace back to ancient times (Du Pisani, 2006). How this awareness is addressed represents a major distinction between the two distinct transition discourses.

The contemporary concept of sustainability originates in pre-industrial Europe, initially introduced within German forestry circles that were alarmed by excessive timber consumption and the danger of resource depletion (Du Pisani, 2006). Their proposals sought to preserve the forests' regenerative capacity by regulating extraction to satisfy the demands of trade, mining, and warfare. Later, attention shifted to coal and oil to accommodate growing populations and industrialisation (Du Pisani, 2006). The escalating threat of resource depletion heightened awareness about sustainable resource use and "stimulated a mode of thinking" that would later influence the discourses shaping global sustainability agendas (Du Pisani, 2006, p. 87).

Notably, the shift in the perception of "sustainability" from subsistence practices to satisfying the demands of competitive markets and technological advancement denotes a distinctly utilitarian approach to nature, regarding it primarily as a "standing reserve" (Heidegger, 1977, as cited in Hui, 2017a, p. 4) – and serves as the foundation of the contemporary sustainability concept. This critical observation is essential to consider when engaging with alternative transition discourses.

Sustainability gained prominence through the strategic reframing of post-war development ideas into "sustainable development" (Sabau, 2020) – yet another rather overused buzzword (Du Pisani, 2006). Within this framework, sustainability represented a moral imperative for ensuring global and intergenerational equity in the distribution of resources and welfare (WCED, 1987). Nevertheless, it also asserted that deviating from the existing socio-economic order and modernisation schemes or halting economic growth was unnecessary (Blühdorn, 2017). Conversely, it emphasised that global economic growth should be accelerated, supported by advancements in technology and science, improvements in efficiency for monitoring and management, and the integration of social and environmental costs into market systems (Blühdorn, 2017).

Consequently, sustainability is presented as a seemingly positive concept, defined in objective and unambiguous terms. However, this perspective obscures its subjective and

normative dimensions (Troullaki et al., 2021). Ultimately, sustainability is reduced to a purely technical issue, thus necessitating technical solutions primarily aimed at achieving environmental-economic win-win scenarios (Blühdorn, 2017; Kovacic et al., 2024). This mindset has failed to address the pressing challenges effectively. Instead, it has provided a series of "palliative" measures (Reinert, 2006). And, frankly, it remains unclear not only *how* sustainability can be achieved but also *what* it aims to achieve and for *whom* (Illich, 1999).

This obscurity extends to the methods by which sustainability is assessed, with a typical, widely used example being the Life Cycle Assessment (LCA) method and its variants. Many applications lack transparency and clarity regarding the assumptions that guide both the process and its results (Troullaki et al., 2021; Wulf et al., 2019). Each assessment tool incorporates underlying values that define its criteria, processes, and ultimately the outcomes. The findings determine what is regarded as "sustainable", which in turn may inform political decisions on policies, extending beyond individual products to entire systems, regions, or sectors of the economy (**I**).

The general ambiguity surrounding sustainability is not incidental but rather a necessary condition to maintain the status quo (Saltelli et al., 2020). Consequently, many inconvenient truths are ignored in sustainability discussions and communication (Voci & Karmasin, 2024; III), as the techniques (e.g., narratives, assessment tools) are neither objective nor neutral (Saltelli et al., 2020; Gasparatos & Scolobig, 2012). The deeper issue with "sustainability", however, lies not in the ambiguity itself but in the failure to acknowledge it (Kouvara et al., 2024).

Moreover, the global unilateral character of sustainability agendas, wherein centralised, top-down strategies dictate the "correct" path for all societies to follow, has systematically overlooked the rich, diverse heritage of subsistence, commoning practices to managing shared resources or producing goods for collective benefit (Nightingale, 2019; Ostrom, 1990). Such practices resonated with local communities' values and needs and were grounded in relational understandings of human-nature interrelations. However, with the gradual spread of the Western worldview as a single truth through colonisation and modernisation, these practices were often dismissed as primitive, or destructive, and were marginalised (Nightingale, 2019). Consequently, the lens through which human-nature relationships, and history, are perceived by dominant approaches is too narrow, which in turn limits our ability to envision alternative options to a sustainable future.

Overall, sustainability is a politically charged and contested concept that currently serves more as a rhetorical device than a genuinely transformative framework (Blühdorn, 2017). Meaningful change cannot be realised if the perceptions, biases and interests that currently shape problems and objectives and dictate the direction and pace of transitions remain unchallenged (Martin et al., 2024).

3.1.2 The debatable role of modern technology

In the technical reasoning of sustainability, modern technology plays a pivotal role, serving as a means to a somewhat vague aspiration. Despite the apparent lack of progress in addressing, or at least halting, the escalating crisis, mainstream narratives – such as "green growth" (Perez, 2019) and "ecomodernism" (Asafu-Adjaye et al., 2022) – continue to assume that sustainability challenges can be solved through advancing technologies. These narratives suggest that economic growth can be decoupled from environmental degradation, despite the persistent failures in this regard (Vadén et al.,

2020) (**II**; **III**). Their assumptions not only oversimplify the complexities of sustainability issues but also ignore inherent pitfalls associated with modern technology.

Modern technology represents the transcription of modernity's ontology and epistemology into technics. This ontology is premised on the fundamental separation between humans and nature, which perceives the conquest of nature and the "othering" of diverse ways of thinking, knowing, and being as essential elements of progress for human civilisation (Barca, 2020; Plumwood, 1993). While this worldview presents itself as universal and deterministic in its assertions about how things are and ought to be, the claimed supremacy of its rationality and tools (e.g., science, technology) rests upon very thin soil.

As a result, modern technology is intertwined with discriminatory systems (e.g., colonial, racial, and gender systems) (Irwin & White, 2019; Paulson, 2024; **II**) and maintains strong ties to the dogma of growth. This reflects the fixation on the notion that growth is a prerequisite for societal well-being and can be achieved only through technological advancement and globalisation (Pansera & Fressoli, 2021; **II**).

The assumed imperative of technological globalisation has driven the spread of standardised homogeneous technologies, marginalising the rich technological diversity (technodiversity) that once flourished across cultures. This technodiversity emerged from distinct epistemological, ontological, and cosmological worldviews, through which societies developed locally embedded and culturally interwoven technologies to meet their needs while maintaining the balance of natural ecosystems (Calisto Friant et al., 2023; Hui, 2022a).

The deep interconnections between relational knowledge systems and technology production are largely disregarded today, leaving little opportunity for diverse technological trajectories to flourish. This decline extends beyond endangered cultural diversity, to biodiversity. For instance, modern pesticides, although designed to universally target specific biological and chemical traits in insects, exhibit effects that vary significantly by location, ranging from beneficial to disastrous (Hui, 2024), often leading to a "pesticide treadmill" where the use of one agrochemical necessitates the application of another (Argüelles & March, 2023). Likewise, genetically modified and standardised seeds, while potentially enhancing yields under shifting climate conditions and facilitating market integration, can severely harm local agrobiodiversity (Mazé et al., 2021).

Furthermore, by prioritising economic interests to drive growth, technology has significantly lost its social purpose, exacerbating the various forms of alienation that characterise neoliberal society and industrial production (Beinsteiner, 2020; Brownhill et al., 2012; Irwin & White, 2019). The ongoing destruction of traditional ways of living, the simultaneous intrusion of expertise and professionalisation (Illich, 1973), along with the centralised development of technology by corporations and government bureaucracies (Huesemann & Huesemann, 2011), has systematically detached people from the knowledge and means of subsistence and production.

This detachment cultivates a dependency on artificial systems and expert knowledge, undermining human agency and autonomy to engage with technology and understand how it mediates, shapes, and interferes with our lives and experiences of the world (Drechsler, 2020; Giambastiani, 2021; **II**). It also indicates an inability to grasp or assess the broader implications, origins, and biases of technology – a condition that Hui (2022a) describes as "technological unconsciousness." This state of unconsciousness, endemic to "homo industrialis," is a critical factor in why modern technology plays such a pivotal role

in the destruction of the biosphere and humanity's future, positioning it as a distinctly political issue (Hui, 2022a).

Thus, modern technology carries profound and often detrimental implications throughout its entire lifecycle – from design and production through distribution and usage to the disposal of artefacts. These repercussions include, among other issues, excessive material flows and energy consumption, toxic waste, loss of biodiversity, exploitation of labour, planned obsolescence, and opaque patent systems that hinder maintenance, repair, and transparent sustainability assessments. These challenges disproportionately impact various communities and ecosystems around the world (Jambadu et al., 2024; Kostakis et al., 2023b; Krebs & Weber, 2021).

Ultimately, the techno-optimist perspective, which views modern technology as a panacea and takes its dominance for granted, is both highly questionable and misleading (Hornborg, 2024; **II**) – nearly verging on belief. Rather than offering a comprehensive response to the complex demands of sustainability (e.g., social justice, ecological stability, cultural resilience), such promises, rather reflect a top-down imposition of hope (Drahos, 2004). These strategies of enforced hope, orchestrated by states, corporations, and scientists, aim to convince the public that this trajectory is the sole viable option; when, in reality, it serves to maintain the status quo and delays social action (Drahos, 2004; Blühdorn, 2017; **II**).

Despite hegemonic narratives continuing to shape sustainability transitions, the increasing recognition of modern technology's implications and contradictions regarding sustainability presents an opportunity to rethink technology in its entirety and diversity (Hui, 2021). This opportunity prompts a questioning of the ontological and political foundations upon which technology unfolds and materialises. Therefore, instead of adopting modern technology uncritically or rejecting it entirely, we could further investigate the possibility of reappropriating it.

3.2 Transition to where? Seeking alternatives pathways

Whether the sustainability paradigm is approaching exhaustion, indicating the arrival of a post-sustainability era as Blühdorn (2017) suggests, or whether heightened awareness of the current predicament signifies the true beginning of the "Sustainability Age" for all (Swilling, 2019), it is undeniably a time of simultaneous stagnation and noticeable, experienced transition. But, transition to where?

Pathways that prioritise technocratic solutions designed to remedy planetary systems and protect ecosystems "without in any way reducing the powers and wealth of the rich and super-rich" (Swilling, 2019, p.5) and while overlooking the prevailing "monoculture of the mind" (Shiva, 1993), portend many bleak futures ahead. If the aim is to genuinely pursue sustainability as a vision of planetary harmonious coexistence for generations to come, the inquiry must be fundamentally reframed.

The complexity, depth, magnitude, and urgency of sustainability issues indicate that continuing on the current path undoubtedly leads straight downhill, head-down, unless someone is willing to jump on a spacecraft to Mars. Even then, I personally would prefer to skip the companionship of Musk and the like; *if* I had any choice (pun intended). The combination of growing mistrust, or even distrust in the supposedly "good" intentions of democratic institutions (Merkel & Lührmann, 2021; Van Prooijen et al., 2022; **II**) and the evident lack of effective solutions so far, presents numerous reasons to feel hopeless, frightened, and immobilized – if not choosing to remain "comfortably numb" (Waters & Gilmour, 1979).

In response to this stagnation and widespread anxiety, alternative discourses have emerged over recent decades, suggesting that new pathways are not only feasible but already present. These discourses first and foremost engage with *thinking* sustainability issues from varied perspectives– where thinking, in this context, "means to provide a new reading that has transformative power," reflecting on our "actual situation and go beyond it to imagine radical openings" (Hui, 2021, p. 57). This serves as the emphasis of the subsequent sections.

3.2.1 Another sustainability: Relationality, diversity and cooperation

Several studies within the broader context of sustainability transitions diverge from the prevailing "neutral" and reductionist approaches, foregrounding critical questions of politics, power, and agency in shaping narratives and potential pathways. These perspectives acknowledge that transitions often lead to uneven social impacts and an inequitable distribution of benefits, which can vary across different contexts. They therefore advocate for more democratic and inclusive processes, emphasising pressing issues of justice (e.g., socio-environmental, labour, energy justice, and indigenous rights) (e.g., Cain, 2024; Doyon et al., 2021; Fischer et al., 2024; Healy & Barry, 2017; Köhler et al., 2019; Sovacool, 2021; Scoones et al., 2020; Velicu & Barca, 2020).

However, more radical perspectives that fall within a broader category of transition/transformation discourses advocate for "significant paradigmatic or civilisational transformations" to achieve meaningful change (Escobar, 2015) or, more ambitiously, to "transition to an altogether different world" (Escobar, 2011, p. 138) – and, more importantly, to "a world where many worlds fit" (Zapatista quote, as cited in Escobar et al., 2024). These discourses incorporate various grassroots perspectives from social movements in both the Global North and the Global South, utilising the concepts of transition and transformation irrespective of traditional academic theories (Feola & Jaworska, 2019).

Although these discourses emerge from diverse intellectual foundations and operate through distinct epistemic and political practices, they find common ground in envisaging life beyond neoliberal globalisation, widely regarded as the root cause of multiple contemporary crises (Beling et al., 2018; Escobar, 2015; Feola & Jaworska, 2019). Consequently, they challenge dominant institutions, power structures, and epistemological barriers that currently exclude alternative understandings of social well-being and the interrelationships between humans and the natural world. Therefore, these discourses engage with politics in transformative processes, including also crucial ontological dimensions, which remain largely absent from traditional discourses.

Despite their diverse backgrounds, distinct similarities exist in how they envision the future, which appear to have naturally emerged from within each social movement (Feola & Jaworska, 2019). Consequently, these varied visions interweave with one another. Their similarities can be identified through three fundamental characteristics: a future composed of relational, communal, and plural worlds (Escobar, 2015). In doing so, they aim to dismantle the dominant Western (Eurocentric, Euro-American, modern) dualist ontology (which maintains separations between nature/culture, human/non-human, body/mind, and so forth. This ontology currently shapes scientific and technical thought, influencing socio-ecological relationships and recognising how these constraints limit possibilities for future coexistence (Beling et al., 2018; Bollier, 2024; Escobar, 2015).

Within these diverse imaginaries, "degrowth" emerges as a critical framework proposing radical and egalitarian socio-ecological transformation towards a future society liberated from the relentless pursuit of growth (Demaria et al., 2013; Kallis & March, 2015). Others suggest varied perceptions of what a desirable world could entail, moving beyond traditional narratives of sustainable development. A pertinent example is "Buen Vivir" – an evolving framework that integrates indigenous (Andean-Amazonian) and critical Western thought to envision new ways of living that prioritise ecological harmony, human dignity, and social justice over economic objectives (Beling et al., 2018; 2021).

Furthermore, the "Commons Transition" discourse presents a pathway to an egalitarian and environmentally sustainable society, and a cooperative political economy that surpasses market competition and bureaucratic demands (Bollier, 2024; Feola & Jaworska, 2019). This discourse originated from Ecuador's "Free/Libre Open Knowledge" initiative, which sought to develop a strategy for an open "social knowledge economy" aligned with the vision of "Buen Vivir" (Feola & Jaworska, 2019). It has since evolved into a global framework that promotes policies generating collective value through open, participatory processes (Feola & Jaworska, 2019). It aims to realign and reimagine traditional commoning practices and cooperative thinking into new institutional forms, framing sustainability transitions as a subversive alternative to the capitalist order, including its more recent iterations, such as netarchical capitalism (Bauwens et al., 2019; Feola & Jaworska, 2019).

Simultaneously, these alternative perspectives seem to converge into the vision of a "pluriverse," which represents an interconnected tapestry of relational, communal worlds, where the collective precedes the individual, and there is an inherent continuity between the biophysical, human, and supernatural realms (Escobar, 2015; 2018). This perspective sharply contrasts with modern dualist thought, which not only posits a strict separation between entities but also leaves the supernatural/spiritual dimension out of the equation (Escobar et al., 2024; Schroyer, 2009). In this vein, rather than endorsing globalisation's "One-World world" doctrine – a singular unified reality propagated through colonialism and development schemes – this concept reframes the "global" as an opportunity to preserve diverse ontologies and ways of being (Escobar, 2015). In doing so, it counters the spatial division of the life-world into binaries such as global/local, Global North/Global South, East/West (and potentially planet Earth/outer space). In this way, the vision of a pluriverse also opens possibilities for reimagining "the plurality of European worlds" beyond Euro-modernity, including the potential for "degrowing into a pluriverse" that transcends capitalism, liberalism, secularism, and the State (Escobar, 2015, p. 460).

The convergence of these various storylines and pathways for change can foster strategic exchange among social movements in sustainability transitions, thereby establishing the foundations for other possible worlds (Beling et al., 2018; Escobar, 2015; Feola & Jaworska, 2019). However, the technology question is neither adequately nor jointly addressed within these discourses (Hui, 2024). This hinders the development of implementation pathways amid the planetary technological condition, as tensions between technological enthusiasm and scepticism remain unresolved (Kerschner et al., 2018; March, 2018). This is why I propose a way to encourage such an inquiry.

3.2.2 Another way to thinking technology: Multiple "cosmo-technics"

The appropriate role of modern technology in sustainability transitions remains a subject of debate (Heikkurinen & Ruuska, 2021). The fundamental challenge is how to reappropriate it – harnessing its potential to foster a healthy future for all while neither overlooking its drawbacks nor romanticising a return to the pre-digital or pre-industrial era.

Responses to the question of technology related to or emerging from the aforementioned alternative discourses on transitions – such as pluriversal technologies (Calisto Friant et al., 2023) or appropriate, convivial technologies (particularly in the context of degrowth) (Kerschner et al., 2018; Vetter, 2018) – exist; however, they fall short in addressing technology "in its totality and in its diversity" (Hui, 2021, p. 112). Firstly, they do not thoroughly consider the multiple dimensions of technology – political, material, ontological, epistemological, and cosmological – while there is a notable lack of critical exchange on this topic across movements. Secondly, they fail to situate technology within our contemporary planetary reality of unprecedented technological acceleration (Hui, 2024).

Drawing on these insights, I propose "cosmotechnics" (Hui, 2017a; 2017b) as a foundational framework for reconceptualising technology in the service of collective transformative change. This framing synthesises critical elements from diverse alternative perspectives and extends the inquiry beyond the prevailing focus on political economy and political ecology – crucial to engage with the question of technology holistically. It has also been catalysing for my exploration of cosmolocal technology, revealing crucial yet unexplored cultural dimensions that demand further research.

Cosmotechnics leverages the "ontological turn in anthropology, which aims to tackle the problem of modernity by proposing an ontological pluralism" (Hui, 2017b, p.2), and suggests delving into the culture-specific assumptions inherent to technology (Hui, 2017a). Thus, it illuminates critical interrelations between the epistemological and ontological dimensions in technology development that dominant discourses tend to overlook.

Cosmotechnics seeks to expand our critical thinking on technology beyond its exclusive association with Greek technē and the Promethean myth, irrelevant to cultures not influenced by Greek philosophy, as did Western European thought (Hui, 2022a). In this light, it "raises the question of technics not as a universal techno-logy," but as a question of multiple locality-specific technics (Hui, 2022a, p.289). Put differently, cosmotechnics hold the thesis that technology is not anthropologically universal but rather "enabled and constrained by particular cosmologies which go beyond mere functionality or utility," grounded in the diverse local/cultural contexts (Hui, 2017b, p. 2).

In this light, cosmotechnics invites an exploration of how non-Western and indigenous ontologies, along with their associated ways of being and knowing, could engage in meaningful dialogue with modern technology and Western metaphysics, to potentially reshape the future development of global technologies (Hui, 2017a; 2022a).

Cosmotechnics is described as "the unification of the cosmos and the moral through technical activities, whether craft-making or art-making" (Hui, 2017b, p. 7). Unification here means more than putting these two entities together; it refers to their dynamic, reciprocal relationship, constantly enforcing each other to acquire new meanings over time (Hui, 2021).

Seen from the lens of cosmotehnics, technology emerges as an ontological category embedded within a larger order of existence – a cosmology deeply connected to its culture

of origin, reflecting both geographic specificities and collective imagination (Hui, 2022a; 2021). Here, cosmologies refer not to scientific theories of outer space, as in astrophysics, or obsolete beliefs, but to localities and their diverse, context-specific ways of knowing and being and understanding morality (Hui, 2021). These distinct cosmological relations concretise in technical activities, including the invention and use of tools, or social and political systems (Hui, 2017a; 2021; 2022b). Thus, just as different localities embody distinct cosmologies, they also give rise to multiple cosmo-technics.

While a universal technical tendency exists – akin to natural laws, where certain technologies like fire-starting with flint or the wheel emerge across civilisations – historically, the diffusion of similar technologies across cultures was filtered and shaped by the constraints of each internal milieu (Hui, 2020). This process of local adaptation differs fundamentally from globalisation and its resulting technological homogenisation.

The concept of cosmotechnics is vividly illustrated by traditional Chinese medicine, which contrasts with the utility and functionality of modern Western medicine; yet it is no less medical (Ekbia, 2023). Chinese medicine operates through the language of Chinese cosmology, employing concepts like ch'i (vital breath), Yin and Yang, and the five movements (metal, wood, water, fire, earth) – principles that cannot be physically demonstrated in anatomy (Hui, 2024). It views the body as a microcosm reflecting the macrocosm, and intrinsically connected with the mind and the spirit (or soul); and heals by restoring internal harmony (Hui, 2022b; 2024; Ng, 2018). Western medicine approaches healing through mechanical scientific application, based on fundamentally different understandings of diagnosis, therapy, and bodily function (Hui, 2022b; Ng, 2018). Notably, despite Chinese medicine's effective continuous practice over thousands of years, its legitimacy is often validated only through confirmation by Western medical standards (Hui, 2022b; 2024).

An important insight from this example, which extends to many vernacular practices, is that Chinese medicine is not an ethnocentric form of technics. Rather, it represents "knowledge that is in principle accessible to everyone and could be practised by everyone" (Hui, 2022b, p.1411). This demonstrates how practices deeply rooted in specific cultural contexts can be shared and adapted across diverse communities without requiring forced adjustments.

Today, certain Chinese medicine practices, like acupuncture, are gaining recognition in Western medicine, largely due to documented patient successes in areas such as pain relief – even when Western scientific methods cannot yet provide their standard quantitative evidence. Similarly, Western methods have been incorporated into Chinese medicine education and practice. This mutual influence, despite differing cosmological frameworks, suggests potential for advancing medicine in a more holistic direction for the common good.

In the process of modernisation and globalisation, the rich variety of cosmotechnics – that is, technodiversity – and the embedded local and indigenous knowledge has been largely lost or diminished to mere historical reflection (Hui, 2024; Santos, 2015). This erosion has conditioned us to think in terms of a singular, universal technological lineage (Hui, 2017a). However, just as there is no singular form of living or thinking, there is no single technology (Hui, 2017b).

In light of environmental catastrophes and the growing risk of losing control over increasingly autonomous technologies, a fundamental reassessment of our approach to technology is essential. This critical inquiry into technology should extend beyond developing more advanced or eco-efficient solutions, beyond retroactively imposing

ethics on Artificial Intelligence and biotechnology (Hui, 2019; 2020), and beyond pursuing yet another unified global solution. These narrow approaches merely perpetuate the current corporate-driven technological monoculture, accumulating ethical constraints until an inevitable breaking point (Hui, 2019; 2021). Meanwhile, international technological competition, driven by economic and military interests, threatens to perpetuate cycles of war, fascism, and nationalism (Hui, 2024). Moreover, restoring locally-rooted traditional technics, while valuable for various reasons (**VI**), is insufficient to pave a collective way out of the planetary technological condition and mounting crises.

Fundamentally, transitioning to sustainable futures goes far beyond mere technical considerations. A transformative shift towards a future of planetary coexistence cannot occur neither by developing a specific technology anew nor by restoring old practices; as the rotting root of our predicament extends beyond the "machine" itself – rather lies in the "machine heart," the "calculative mind" (Hui, 2022a)[8].

Instead, a promising path lies in envisioning different technological futures, inspired by diverse systems of technological thought (Hui, 2022a; 2024). This approach moves beyond the current trajectory of modern technology – confined by modernity, capitalism, and the Promethean myth – to exploring how multiple contemporary cosmotechnics could re-emerge (Hui, 2017a). Cosmotechnics, as a lens to thinking technology, opens new possibilities for reappropriating modern technology by investigating how non-Western perspectives and metaphysical categories can contribute to its transformation rather than its rejection (Hui, 2024; Hui, 2022a). This could foster "a new geopolitics that is not based on an apocalyptic singularity, but on technodiversity; this is also why cosmotechnics is a political concept" (Hui, 2019, p. 277).

Building on this understanding of cosmotechnics, I next examine how cosmolocal technology can facilitate such an exploration, serving as infrastructure for transformative visions to potentially move from imagination into practice.

[8] In an ancient story associated with Zhuangzi (late 4th century BC, pivotal figure in Daoism), a man named Zigong meets an old farmer who is manually drawing water from a well. Zigong, observes that the old man "used up a great deal of energy but produced very little result" (Hui, 2022). So he says to him, as would someone chanting the mantra of efficiency today, "There is a machine for this job." The old man responds, "I've heard my teacher say, where there are machines, there are bound to be machine worries; where there are machine worries, there are bound to be machine hearts. With a machine heart in your breast, you've spoiled what was pure and simple, and without pure and simple, the life of the spirit knows no rest […] It's not that I don't know about your machine—I would be ashamed to use it!" (Zhuangzi story, as cited in Hui, 2022a, p. 106). A more precise translation for "machine heart" (*ji xin*) would be "calculative mind" (Hui, 2022a). Zhuangzi probably means that "one should avoid developing such reasoning about life, so as not to lose the way [Dao], and along with it, one's freedom; if one always thinks in terms of machines, one will develop a machinic form of reasoning" (Hui, 2022a, p.106).

4 The transformative potential of cosmolocal technology

The prevailing story that we have inherited from the West has become “a dysfunctional cosmology” that functioned, at least for some, for a long time, but “it is no longer the story of the Earth. Nor is it the integral story of the human community. It is a sectarian story.” (Berry, 1988 in Escobar et al., 2024, p. 2). These words, which I attempted but could not transcribe any other way, capture the simple yet fundamental truth that global sustainability agendas and traditional transition discourses seem to ignore.

The current predicament stems from this dysfunctional cosmology manifesting in modern technology and its implications. Modern technology thus emerges as the “contemporary cosmotechnics that dominate the planet” (Hui, 2022a, p. 299), founded on reasoning that is “fundamentally against the conditions of subsistence and existence” (Hui, 2019, p. 275). Against this backdrop, cosmolocal technology may present itself as a countering cosmotechnics of a future to come, where prosperity ceases to be a sectarian story and becomes a planetary one.

In what follows, I examine why and how cosmolocal technology holds this potential, and what makes this potential transformative. My analysis rests on the premise that cosmolocal technology addresses the material, political, and ontological dimensions of technology simultaneously, while embracing a broader vision of planetary coexistence – transcending artificial binaries (Table 1) to tackle more substantive oppositions (Table 2) that currently remain unaddressed.

4.1 Transcending artificial binaries

A series of binaries currently dominate debates surrounding technology, production, and sustainable futures – global versus local, high-tech versus low-tech, modern versus traditional, scalability versus “nonscalability” (Tsing, 2012; 2015). While these dichotomies can provide fertile ground for dialogue and critique, they often create unnecessary confusion when proposing practical solutions. This confusion is unnecessary for two reasons. First, these binaries distract from the real challenges at hand; debates about the superiority of one approach over another obscure underlying biases and assumptions. Second, the resolution to these apparent dilemmas may lie in their creative integration. Cosmolocal technology offers precisely this possibility: a reframing of technology beyond such binaries to address more fundamental challenges.

Challenging dominant narratives, one end of the spectrum consists of proposals that oppose the dominance of techno-optimism and its faith in modern technology’s universal solutions. These proposals combine different elements in multiple ways. Some advocate for “low-tech” solutions – simple, frugal technologies that demand fewer resources and less energy. Others emphasise “local” approaches through decentralised and localised production, respecting bio-physical limits while leveraging local knowledge. The notion of “local,” however, can span various scales, from specific ecosystems to state boundaries, depending on context and challenges. “Traditional” is typically approached in terms of reviving or adapting indigenous techniques rooted in local knowledge. The idea of “nonscalability" (Tsing, 2012) promotes solutions that remain grounded in specific local conditions, contrasting with those intended for global uniformity.

While these proposals offer important critiques of the current trajectory, they alone cannot provide sufficient practical responses to global challenges. Cosmolocal technology, however, offers a different approach – one that resolves such binaries by demonstrating how their elements can be reinterpreted and integrated (section 1).

First, through its organisational structure, cosmolocal technology blends global connectivity with localised practices. This simultaneous local-global orientation empowers local autonomy and sufficiency while fostering a sense of shared global benefit (Schismenos et al., 2020). In contrast to capitalist interpretations, the cosmolocal framework views the global as a network of interrelated, diverse small-scale, locally-oriented communities (Kostakis et al., 2023a). Here, locality exists in dynamic exchange with the global while remaining grounded in its integral specificities. Second, adopting a mid-tech approach bridges the gap between low- and high-tech, or modern and traditional, enabling the integration of situated knowledge into new technologies without privileging one over the other. Third, by proposing an alternative approach to scalability, it challenges the unsustainable imperative of upscaling at all costs driven by uniform industrial technologies. Instead, it embraces “scaling wide” or "scaling out" enabled by collaborative networks of commoners – thus suggesting a new politics of scale (Kostakis et al., 2023a; **IV**).

The transformative potential of cosmolocal technology lies partly in its capacity to transcend these binaries through their unification in practice. However, more fundamental oppositions – arising from ontological and political struggles inherent to transitions – also demand attention, and here too, cosmolocal technology takes a clear stance.

***Table 1**. Artificial binaries and how cosmolocal technology addresses them – as a configuration for technology development/production, and approached through the cosmotechnics lens.*

binaries		**cosmolocal technology**	**cosmotechnics**
global Global North	local Global South	global-local orientation global exchange local production	local culture cosmic dimension planetary condition
high-tech modern	low-tech traditional	middle-tech	technodiversity, multiple cosmotechnis
scalability (scale up)	non-scalability	scale-wide via commons-based networking	planetary thinking beyond nation-states and ethnocentrism

4.2 Addressing oppositions

4.2.1 Diversity vs Monoculture: Reappropriating techno-diversity

Although the commons is mainly discussed from an organisational perspective (Mandalaki & Fotaki, 2020), as a social system, its significance extends beyond economics, public policy, or politics. At its core, it represents a distinct mode of human existence (ontology) and knowledge (epistemology) that differs fundamentally from the established Western worldview (Bollier, 2014; **V**). The essence of this distinction lies in the relational and communal understanding of the world, where all aspects of life are mutually interconnected, and personhood is intrinsically interwoven with the web of life (Escobar, 2015). This ontology of the commons manifests in how communities of commoners organise and operate within and beyond their locality, as well as in their technological creations.

In this light, commons-based technology development incorporates both ethical principles and moral values that prioritise the collective over individual benefit – where the collective encompasses not only community members but extends to society, to the natural world – to "life-world" as a whole. This ontological, ethical-moral foundation guides the production and application of commons-based technologies.

Hence, the distinct characteristic of commons-based technology, as opposed to modern technology, is that while it retains a shared ontological/ethical-moral core it manifests in diverse ways within different localities and cultures (section 1). In traditional contexts, this foundation is more visibly intertwined with the various cosmologies rooted in each locality. This culturally embedded diversity has largely eroded through modernisation processes (sections 3.1.1, 3.1.2), but the commons, despite being marginalised in contemporary life, have not ceased to exist (Bollier & Helfrich, 2019) (section 1).

Cosmolocal technology is one such contemporary manifestation of the commons. It provides a framework that can be adapted to different contexts (geographical, cultural, cosmological) and a template for harnessing the benefits of the digital epoch for collective benefit, without compromising its inherent commons values. Thus, cosmolocal technology does not propose an ideal model of a single universal technology, but a universal trajectory that integrates diversity, opposing the "universalisation of homogeneity", which is currently the case (Hui, 2024, p.242). In this sense, cosmolocal technology establishes the groundwork for a practical response to the pressing issue of technology – and particularly the pursuit of technodiversity – potentially fostering the re-emergence of multiple contemporary cosmotechnics.

Seen through the lens of cosmotechnics, cosmolocal technology is positioned within the ontological struggles, offering the opportunity to investigate the possibility of technodiversity – a quest into how non-Western perspectives rooted in different cultures and cosmological understandings could influence the development of future technologies. More specifically, it denotes the possibility of commons-based technodiversity.

While exploring such a possibility might not work well in urban settings, which remain detached from natural life, it makes more sense for rural settings, which are in more direct connection to the natural world, and where rituals, traditions and practices reflecting these associations remain alive, or struggling to. That is also why the example of "Tzoumakers" (the pilot cosmolocal initiative that we studied and which I have been engaged with), located in a remote mountain village, turns out to be fruitful ground to initiate such an effort (**II**). In this light, while the cosmolocal framework is argued to provide the tools and structures for cross-spatial organising for change (Kostakis et al., 2023a), it also provides the infrastructure for a systematic cross-cultural exploration of technology under the scope of reappropriating technoldiversity beyond homogeneity.

Furthermore, this deeper understanding of the ontology of the commons, is essential to distinct cosmolocal communities that adhere the relational ontology of the commons, from other communities who just follow the same organisational arrangement (i.e. open global knowledge exchange, combined with localised production), but ignore the rest. Could a community that exchanges designs for 3D printed weapons in the dark web[9] be considered a cosmolocal one? Simply no. There are fundamental qualitative differences lying in these deeper ontological elements, indicating how cosmolocal technology

9 https://www.wired.com/story/3d-printed-guns-blueprints/

interrelates with the larger cosmic reality and how it envisions a desirable future. Yet this dimension remains largely under-explored.

In short, cosmolocal technology holds the potential to facilitate the investigation and possibly the formation of an altogether different trajectory for technology stemming from the grassroots and premised on technodiversity and the relational ontology of the commons.

4.2.2 Engagement vs Alienation: Reappropriating technological autonomy

From a more socio-political perspective, cosmolocal technology emerges as a response to the growing alienation and disengagement from technology, over-dependence on proprietary, "one-size-fits-all" solutions, opaque systems and expertise. By extension, it also responds to the limited opportunities civil society has to comprehend the complexity of sustainability challenges, let alone to meaningfully contribute to addressing them.

Against this alienation and disengagement, the cosmolocal framework offers numerous ways to restore some extent of social technological autonomy – grassroots technological sovereignty (Giotitsas, 2019) – through cooperative, convivial, and democratic processes. Communities are provided access to shared infrastructures, equipment and tools, knowledge resources, and support networks/systems, to produce adaptable, repairable, open-source solutions to meet needs (not greed), leverage and enrich digital commons, and ensure transparent sustainability assessments. Cosmolocal technology fosters a mindset around technology as to primarily serve a social purpose, which in this case extends beyond the locality and a specific local community.

By fostering hands-on engagement with technology, commoners have many opportunities to cultivate skills (e.g., use of tools, digital literacy, etc.), collective ingenuity and grassroots innovation (Troullaki & Rozakis, 2024); skills that enhance their abilities to comprehend, develop and use technology. They are also empowered to cultivate a broader understanding of technology (technological consciousness), getting a hands-on experience of the whole spectrum of processes that encompass the production of technology, and its potential implications. In this sense, commoners are enabled to become more conscious of modern technology and the current predicament.

This, in turn, holds the potential to foster active and more conscious citizenship, where through collective action, communities can resist or inform policy decisions or suggest alternative directions (**II**). In this sense, direct engagement with technology could foster the much-needed "transdisciplinary" approach to sustainability research and policy making, which requires the contribution of multiple actors, disciplines and real-world perspectives – pluralistic expertise (Rau et al., 2018) – to define problems and develop solutions to sustainability challenges holistically (Troullaki et al., 2021).

This "democratisation" potential is further leveraged by the ways cosmolocal networks utilise digital connectivity. Namely, by facilitating open knowledge exchange, while fostering global collective action in the re-making of a future society – beyond "smart citizens" and data providers (Kovacic et al., 2024; March, 2018), beyond "governance by numbers" (Saltelli et al., 2024), beyond the "industrialisation of social relations" (Hui & Halpin, 2013).

Nevertheless, given that heterogeneous interpretations of already contested and elusive concepts, such as sustainability and technology, persist even within the same local contexts (Berglund & Kohtala, 2020; Vetter, 2018), commoners are constantly met

with the necessity of being conscious and alert to each concept's underpinnings. This presents a challenging task. However, by engaging in inclusive processes, they are also empowered to actively participate in reappropriating and co-defining the meaning of certain buzzwords – which is vital to ensure that their creations remain aligned with their vision, and that diverse perspectives are equitably accounted for.

Abandoning or attaching new meaning to concepts, or introducing new vocabulary – i.e. new vernacular language, accessible, relatable, inclusive and "homegrown" (Illich, 1980) – is in fact, crucial for the current prefigurative stage. It is also fundamental to enable transformative change (Loring, 2020; 2023).

Technological autonomy, in the context of cosmolocal technology, simultaneously demands and fosters a conscious engagement with technology and the broader complexities of sustainability challenges. Ultimately, this need, which naturally emerges from the non-hegemonic, democratic character of cosmolocal technology, necessitates a dynamic reinvention of a vernacular language that will accompany not just transformative but *meaning-full* change.

4.2.3 Hope vs Despair: Reappropriating techno-optimism

Empowering hands-on engagement in the making and making sense of technology and impacts of modern technology, is directly linked to enhancing people's ability to discern fraudulent techno-optimist hopes from actual possibilities (**II**). This, in turn, not only promotes democratic, responsible, heterogenous and reflexive decision-making to serve the collective (instead of corporate) interest in sustainability transitions; but may also encourage the practice of collective hope (Braithwaite, 2004) (**II**).

In the face of ineffective solutions and feelings of despair and anxiety against a future of impending doom of environmental collapse and uncontrollable superintelligent systems, collective hope – intertwined with collective action – empowers social mobilisation against dogmatic narratives that presuppose a unified high-tech future as the only path forward. Such assumptions are largely debunked and somewhat exhausted; even illusionary (Hornborg, 2024).

Cosmolocal technology already demonstrates that another technological trajectory is in the making, able to host many alternative visions for a future of planetary coexistence. In this light, techno-optimism may acquire a new meaning, reflecting the potential of society-driven and culture-embedded technology – countering the rather pessimistic belief that the current regime is the best we can do.

***Table 2**. Oppositions that cosmolocal technology raises and aims to address.*

oppositions		**refer to**	**affect**
monoculture	diversity	ways of living, thinking, knowing, relating, making	inclusion, justice, fairness, biodiversity
alienation/ dependence	autonomy/ engagement	means of production (design, manufacturing), possession of know-how, inclusion in decisions	subsistence, democracy
despair	hope	collective/social action or stagnation	active citizenship, social imaginary and emancipation
ignorance	awareness	critical reflection/ understanding of impacts, origins, biases and how technology influences thinking and actions	informed assessments, decisions, policy, action

5 Conclusions

Transitioning to a future of planetary coexistence may be determined by which worldview prevails (Escobar et al., 2024). But even so, there may not be enough time to "transition" after all. Humanity, as a whole, may have long since lost the chance to be active participant in any meaningful change, and either Nature or Artificial Intelligence will ultimately take full control. Or, there may be a twist (this is a point where you can unleash your imagination).

If the present story unfolds without a twist, we may as well continue as colonisers of other planets or as lonely hitchhikers in the galaxy (Adams, 1979). Yet, the truth is that neither predictive models nor theoretical contemplations can grasp how many other countless possibilities may be.

We are somewhat forced to deal with the uncertainty of a future made of this, for many reasons dark, present, and while this confrontation may provoke stagnating feelings, it also presents a great opportunity to continue trying, not to predict, but to mobilise. This present stage of uncertainty is what this thesis is actually about – our current earthly condition and collective action taking place (or could be) against all odds at this moment of deep perplexing crises.

In this vein, I focus on exploring the potential of cosmolocal technology – a contemporary reflection of the commons in technology – to initiate transformative change: meaningful change against the prevalence of eschatological thinking – a technological apocalypse looms – currently diminishing our imagination regarding technological advancement (Hui, 2024, p. 242). This potential change also counters the hegemony of an ignorant, corporate-driven techno-scientific regime that consistently contradicts itself on the path to a sustainable future. Nevertheless, this sharp critique does not target modern technology and science as neutral, solitary material and intellectual entities; nor us, the people who appraise and utilise them and are consciously or unconsciously influenced and shaped by them. It is also not a critique aimed at the nation-border-defined states of the West, since the planetary condition recognises no such boundaries (Hui, 2024). Instead, it is a call to challenge and reconsider the very onto-political foundations that currently drive technological thought and how technology is predominantly perceived and developed. Thus this critique addresses the assumptions that drive modernisation, globalisation, economic and power competition, arrogantly marginalising, undermining, and oppressing alternative ways of being and knowing from which there is much to learn. This mindset narrows rather than expands future possibilities.

As a result of personal hands-on experiences and this research work, I am drawn to the idea that a complete civilisational shift towards an "altogether different world" (Escobar, 2011, p. 138) is essential. While this may sound implausible, it effectively underscores the depth and complexity of the transformations necessary for meaningful transitions.

While traditional discourses remain attached to the current power structures, alternative discourses cannot rely solely on counter-political action toward justice or different socio-economic and socio-technical configurations to maintain the effect of change in the long run. Neither can rely solely on action from one specific movement or the other, nor can they rely solely on critique.

There is pretty much a tacit consensus amongst advocates of radical change, that pathways to meaningful transformations need to be relevant to the planetary condition,

and to the vision of an inclusive pluriversal world, beyond geopolitics and politics of scale founded on global-local, Global North-Global South, West-East dichotomies. Yet considering the catalytic role technology plays in exacerbating or potentially addressing the crises, and the pivotal role modern technology currently plays in driving research, policies and transformative action, alternative imaginaries urgently need to jointly engage with the lingering, contentious question: what technology exemplifies a different world?

Fixation on homogenising modern technology (which constitutes the canon of Western thought and capitalist expansion) has constrained our understanding of different future possibilities for technology (Hui, 2024) and, thus, the development of alternative options for sustainability transitions. Within the context of alternative discourses, that converge through their critique of the status quo and position their imaginaries upon relationality and diversity, a response to the question of technology cannot be found in one single unified model, intended to be universally adopted. Instead, it should come from a trajectory that embraces technodiversity – not only in the sense of fostering the production of solutions that can *adapt to* local contexts to meet social needs and account for ecological stability. But also in the deeper sense, of allowing different technologies (e.g., tools, practices) to *emerge from* the diverse cultural contexts, incorporating the diverse cosmologies and context-specific values of each locality. The question of technodiversity (beyond ethnocentrism) is pivotal in exploring and substantiating "alternatives to the current impasse of innovation and development" (Hui, 2024, p.221).

From this point of stagnation, where the dominant narratives appear to have reached their limits, stuck in unsustainable loops, I propose that cosmolocal technology has the potential to de-stabilise prevailing notions and practices, and mobilise collective transformative action toward technodiversity. Though visionary, this understanding of cosmolocal technology indicates a technological future that is as much possible as it is *im*possible.

The transformative potential of cosmolocal technology lies in two critical attributes. First, it refers to the capability of cosmolocal technology to reside within the dominant systems, functioning as a transformative force in its own right – enabling further collective/social action, challenging existing power dynamics, and provoking systemic/structural change. It encompasses a viable technological alternative that, despite facing significant limitations, is evidently evolving among grassroots communities worldwide, representing a contemporary manifestation of traditional commons-based practices. Second, its potential pertains to the capacity of cosmolocal technology to empower alternative visions to flourish, providing a practical response to the question of what technology could facilitate their proposed transitions. It constitutes an adaptable *infrastructure*, rather than a unilateral technology, to be utilised within diverse localities, both in terms of geography (e.g., urban, rural) and culture – thus also addressing the question of technodiversity beyond nation-states and beyond the substantiation of tradition.

The dual potential of cosmolocal technology is evident in its fundamental characteristic of leveraging modern technology, albeit on a significantly different basis than dominant transition approaches: it does not reject but rather repurposes its advantages for collective benefit while aiming to mitigate its drawbacks. In doing so, cosmolocal technology transcends artificial binaries (e.g., global/local, high-/low-tech, etc.) (Table 1) that lead to dead ends in the quest to collectively address planetary

challenges. Instead, it suggests the creative integration of the constitutive elements of these binaries: through a simultaneous global-local orientation and a mid-tech approach, it overcomes the constraints of locality and global homogeneity, harnesses digital connectivity for collective benefit, and incorporates local knowledge along with the autonomy of low technologies to produce tailored, low-impact solutions.

Furthermore, it addresses more critical oppositions (Table 2) that hinder the ability of diverse social actors to drive change. Cosmolocal technology embraces diversity on various levels, considering different cultural specificities, individual perspectives, social needs, and local ecosystems. It offers tools not only to create adaptable, tailored technological solutions but also to develop new inclusive and appropriate language. This latter quality facilitates the resolution of tensions and inconsistencies arising from different interpretations of ambiguous concepts (e.g., sustainability, technology, transitions). Finally, by enabling the reappropriation of technological autonomy, it nurtures collective ingenuity, technological consciousness, and the practice of collective hope, catalysing action towards meaningful transformations stemming from the grassroots up (**II**; **III**; **IV**).

In summary, cosmolocal technology is presented here as an alternative technological pathway already in practice, providing both the conceptual and technical framework to serve alternative imaginaries that are disproportionately present in the current socio-political and ontological struggles. Thus, it demonstrates that prefigurative change is already occurring, and if substantially supported, rather than left to operate in the shadow of institutional support, public recognition, and academic research (Bartels, 2024; Bollier, 2024; **III**), it could expand the possibility of a desired twist in *our* story.

Despite cosmolocal technology being far from a perfect and mature trajectory, further grounded research could help leverage its full potential. Adopting a cosmo-logical approach to cosmolocal technology, enabled by the framework of cosmotechnics, underscores the importance of technological diversity (akin to bio-cultural diversity) and suggests another way to investigate its transformative potential beyond the discourse of political economy/ecology (Table 3). This area of research is integral to the core of the commons (governance, organisation, ontology, epistemology) and equally crucial in deepening our understanding of the emerging cosmolocal phenomenon. However, this aspect has not been thoroughly investigated.

So far, grounded research on cosmology technology has been primarily informed by initiatives in the Global North within similar socio-political and cultural contexts. However, while there are various cosmolocal cases in different contexts (in the Global South), research has not yet substantially examined what non-Western perspectives (including different cultures, spiritualities, religions, and local traditions) can contribute to both the substantiation of the cosmolocal trajectory and its potential to pave the way towards technodiversity.

As our understanding of how cosmolocal technology integrates with and promotes (techno)diversity remains uncertain, future research should concentrate on a more systematic study of this potential, initially based on the various cosmolocal initiatives currently active worldwide. To this end, it is essential to create new conceptual frameworks and employ relatable forms of communication to ensure inclusive, transdisciplinary, cross-cultural investigation.

The outcome of any creative endeavour that does not sit well with dominant institutions and *their* story cannot be predicted, and there is always the risk of being co-opted by powerful interests (Feenberg, 1999). However, it is by embracing this

uncertainty that change can take place. If the full potential of any transformative effort were evident from the outset, it might have been suppressed in its very early formation. It is the capacity to adapt to change that sustains life, after all. Exploring the ontological, cultural, and cosmological/spiritual dimensions of cosmolocal technology is not only valuable for broadening the scope of theoretical contemplation for its own sake. It also serves as a political act that questions and challenges established norms of rationalisation, aspiring to inspire and foster more inclusive and resilient technological practices. This is why, above all, I approach technology primarily as a question of *living* (Hui, 2022a), and cosmolocal technology as a potential response in the pursuit of sustaining life, envisioning a future of planetary coexistence.

***Table 3**. How the frameworks of cosmolocalism and cosmotechnics can integrate to open new research areas for further exploration of the transformative potential of cosmolocal technology.*

<table>
<tr><th>Framework</th><th colspan="2">cosmo-localism</th><th colspan="2">cosmo-technics</th></tr>
<tr><td rowspan="2">Description</td><td colspan="2">configuration for technology development/production</td><td colspan="2">philosophical lens to thinking technology</td></tr>
<tr><td colspan="2">global knowledge exchange
localised production
based-on the commons</td><td colspan="2">unification of cosmic and moral dimensions manifesting in technical activity</td></tr>
<tr><td>What is about?</td><td>making</td><td>socio-political aspects, materiality</td><td>making sense</td><td>ontological, cosmological, spiritual aspect</td></tr>
<tr><td>Why useful?</td><td colspan="2">practical/empirical tool</td><td colspan="2">theoretical tool</td></tr>
<tr><td>Approach to technology?</td><td colspan="2">conviviality, relationality, autonomy, openness, democratisation</td><td colspan="2">cultural embeddedness, technodiversity</td></tr>
</table>

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Abstract

Transitions to where? Exploring the transformative potential of “cosmolocal technology” in quest of future coexistence

While techno-optimist narratives depict the current technological trajectory as inevitable and adequate, critical perspectives emphasise how this narrow view constrains our collective ability to imagine alternative future possibilities. In contrast to misplaced hopes that modern technology alone will resolve escalating planetary crises, this thesis explores the transformative potential of “cosmolocal technology” – an emerging approach to technology development that combines global knowledge exchange with localised production – as a foundation for alternative technological pathways.

Drawing upon four original publications, prior research on the cosmolocal phenomenon, and theoretical perspectives from various transition discourses associated with social movements challenging the dominant regime, I investigate how technology could foster plural ways of being, knowing, and creating, countering the detrimental universalisation of homogeneity driven by technological globalisation. The research employs “cosmotechnics” as a philosophical framework to engage with technology’s cultural embeddedness and ontological dimensions – elements often neglected in conventional sustainability approaches yet essential for paving pathways to meaningful change.

The thesis presents three key contributions: it links empirical research on cosmolocal technology with broader inquiries into sustainability challenges; reinforces connections between the cosmolocal framework and alternative transition imaginaries that contest techno-managerial perspectives; and conceptualises cosmolocal technology as an infrastructure for collective action towards futures rooted in relational communal worldviews.

I argue that the transformative potential of cosmolocal technology arises from its capacity to enable grassroots reappropriation of modern technology for the collective benefit. The cosmolocal configuration transcends conventional dichotomies (global/local, high-tech/low-tech) while addressing fundamental tensions related to diversity, agency, and hope. Crucially, it offers a practical means for exploring technodiversity – how diverse cultural and cosmological perspectives could expand our understanding of technology beyond the assumptions of Western modernity.

While cosmolocal technology remains an evolving phenomenon, its emergence demonstrates that prefigurative change is already taking place. This thesis positions it within broader socio-political and ontological struggles and suggests new research directions on how non-Western perspectives could enhance its transformative potential and inform the development of future technologies in the quest for planetary coexistence.

Lühikokkuvõte

Üleminekud kuhu? “Kosmolokaalse tehnoloogia” transformatiivse potentsiaali uurimine tuleviku kooseksistentsi otsingul

Kuigi tehno-optimistlikud narratiivid kujutavad praegust tehnoloogilist trajektoori vältimatuna ja piisavana, rõhutavad kriitilised vaatenurgad, kuidas see kitsas vaade piirab meie kollektiivset võimet kujutleda alternatiivseid tulevikuvõimalusi. Vastandina ekslikele lootustele, et tänapäeva tehnoloogia üksi lahendab kasvavaid planeedi kriise, uurib see väitekiri “kosmolokaalse tehnoloogia” transformatiivset potentsiaali – tekkivat lähenemist tehnoloogia arendamisele, mis ühendab globaalse teadmiste vahetuse lokaalse tootmisega – kui alust alternatiivsetele tehnoloogilistele radadele.

Toetudes neljale originaalpublikatsioonile, varasematele uuringutele kosmolokaalse nähtuse kohta ja teoreetilistele perspektiividele erinevatest ülemineku diskursustest, mis on seotud domineerivat režiimi väljakutsuvate sotsiaalsete liikumistega, uurin, kuidas tehnoloogia võiks soodustada pluralistlikke olemise, teadmise ja loomise viise, vastandudes tehnoloogilise globaliseerumise poolt juhitud kahjulikule homogeensuse universaliseerimisele. Uurimus kasutab “kosmotehnikat” filosoofilise raamistikuna, et tegeleda tehnoloogia kultuurilise juurdumise ja ontoloogiliste dimensioonidega – elementidega, mis on tavapärastes jätkusuutlikkuse lähenemisviisides sageli tähelepanuta jäetud, kuid on olulised tähenduslike muutuste teede sillutamiseks.

Väitekiri esitab kolm peamist panust: see seob empiirilised uuringud kosmolokaalse tehnoloogia kohta laiemate jätkusuutlikkuse väljakutsete uuringutega; tugevdab seoseid kosmolokaalse raamistiku ja alternatiivsete ülemineku kujutluste vahel, mis vaidlustavad tehno-juhtimislikke perspektiive; ja kontseptualiseerib kosmolokaalset tehnoloogiat kui infrastruktuuri kollektiivseks tegevuseks tuleviku suunas, mis põhineb relatsioonilistel kogukondlikel maailmavaadetel.

Väidan, et kosmolokaalse tehnoloogia transformatiivne potentsiaal tuleneb selle võimest võimaldada rohujuure tasandi kaasaegse tehnoloogia taasomastamist kollektiivse kasu nimel. Kosmolokaalne konfiguratsioon ületab tavapärased dihhotoomiad (globaalne/lokaalne, kõrgtehnoloogiline/madaltehnoloogiline), tegeledes samal ajal põhiliste pingetega, mis on seotud mitmekesisuse, tegutsemisvõime ja lootusega. Mis eriti oluline, see pakub praktilist vahendit tehnomitmekesisuse uurimiseks – kuidas erinevad kultuurilised ja kosmoloogilised vaatenurgad võiksid laiendada meie arusaama tehnoloogiast väljapoole lääne modernismi eeldusi.

Kuigi kosmolokaalne tehnoloogia on endiselt arenev nähtus, näitab selle esilekerkimine, et prefiguratiivne muutus juba toimub. See väitekiri positsioneerib selle laiemate sotsiaal-poliitiliste ja ontoloogiliste võitluste konteksti ning pakub välja uusi uurimissuundi selle kohta, kuidas mitte-läänelikud perspektiivid võiksid tugevdada selle transformatiivset potentsiaali ja informeerida tuleviku tehnoloogiate arendamist planeetaarse kooseksistentsi otsinguil.

Appendix 1

Publication I

Kouvara, A., Priavolou, C., Ott, D., Scherer, P., & van Zyl-Bulitta, V.H. (2023). Circular, Local, Open: A Recipe for Sustainable Building Construction. *Buildings*, *13*(10), 2493. **ETIS 1.1.**

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Article

Circular, Local, Open: A Recipe for Sustainable Building Construction

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Abstract: In response to the construction sector's contribution to the climate crisis and exacerbation of social inequalities, we explore sustainable alternatives in building construction, informed by the illustrative case study of the Polycare construction system. First, through a Life-Cycle Assessment (LCA) method, we show that the ecological footprint of circularity-oriented buildings based on polymer concrete is significantly lower than that of conventional cement concrete buildings. Despite the drawbacks of polymer concrete, its high-performance properties and the possibility to integrate secondary materials in its recipe can result in a reduced carbon footprint. When coupled with design-embedded modularity that facilitates circular processes (e.g., the disassembly and reuse of building components), buildings similar to those in the case study demonstrate potential for transitioning towards comprehensive sustainable building practices. Further, we discuss how this sustainability potential could be enhanced, drawing from interviews with Polycare's stakeholders and key literature findings. In this direction, we provide a set of proposals anchored in the argument that threefold "circularity, localisation, and openness" is vital for sustainable and affordable alternatives, with openness being a crucial element for fostering innovation, adaptability, and scalability in building processes.

Keywords: circularity; localisation; openness; sustainable building; polymer concrete; life-cycle assessment

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1. Introduction

The construction sector accounts for a large share of the climate crisis and social inequality. Conventional building practices follow linear production models, which depend on global value chains and the extensive use of unsustainable materials. The most crucial environmental consequences of dominant practices are significant carbon emissions, natural resource exploitation, high energy demands, and waste production [1]. Other implications include labour-intensive activities, illegal or unmonitored mining and waste export, gender discrimination, and corruption [2–4]. Additionally, increasing costs for building construction and energy, coupled with the lack of policies to support sustainable building materials/practices, have hindered access to decent housing for middle- and low-income households, even within affluent economies [5–11].

With the demand for urban housing projected to rise substantially by 2050 [11], there is an urgent need to develop sustainable and affordable building solutions that address both environmental and social concerns [9,11–13]. The relevant literature suggests that holistic changes encompassing the entire life cycle of buildings are crucial [7,14,15]. Such changes mainly promote the adoption of circular (e.g., recycling, remanufacturing, repair, and reuse), localised (e.g., local material resources and the manufacturing of building components), and open (e.g., open-data, open-design, and open-software/hardware) practices. In this

way, it is possible to extend the lifespan of building components [16–18], increase resource efficiency [19,20], yield socio-environmental benefits [21,22], and ensure the transparency of supply chains and sustainability assessment methods [7,23,24].

In this article, we argue that the integration of circularity, localisation, and openness, is fundamental for achieving comprehensive sustainability in building construction. To substantiate this claim, we explore the sustainability potential of "Polycare" and their "Polyblock" system, a construction system oriented towards circularity. Selected as a representative case, Polycare addresses multiple aspects and current challenges associated with sustainable building construction. In short, Polycare's Polyblock system is a modular structural system made of polymer concrete, an alternative to conventional cement concrete, which shows potential for developing sustainable and affordable housing solutions. We employ the Life-Cycle Assessment (LCA) method to assess the ecological impact of Polycare structures and compare it with that of conventional cement concrete structures of identical shapes and sizes. This quantitative analysis is supplemented with a qualitative assessment informed by literature and interviews to discuss how initiatives, like Polycare, could enhance their socio-environmental impact. The discussion is centred on threefold "circularity, localisation, and openness", suggesting ways for their further adoption by Polycare and similar initiatives. Lastly, we pinpoint obstacles and deliberate on how institutional support and strategic partnerships could catalyse sustainable transitions in the construction sector.

The article unfolds as follows: Section 2 summarises key literature findings regarding the three critical elements for sustainability in building construction, i.e., circularity, localisation, and openness. Section 3 delineates the methods and tools utilised, while Section 4 provides an overview of the Polycare construction system. Section 5 presents the results of the comparative LCA analysis followed by a critical discussion regarding the sustainability potential of Polycare and similar initiatives. The conclusion, in Section 6, reflects on the preceding sections, addresses the limitations of this study, and offers recommendations for future research and action.

2. Tracing Sustainable Approaches to Building Construction

Maintaining a balanced relationship between environmental, social, and economic aspects of sustainability in building construction is a burning issue on a global level [9,11,12]. Despite the need for integrated approaches to sustainability issues, the focus is usually on the building's environmental performance and energy efficiency, primarily to minimise their life-cycle carbon footprint [14,15,24–28]. However, buildings are complex systems that involve several stakeholders, and their impact extends beyond the environmental dimension. In this direction, several studies also address the socio-economic aspects of sustainability in building construction, particularly in the case of housing. These aspects include affordability, addressing local needs and capacities, as well as enabling the participation of various actors in the building process [6,7,29–31]. Through a literature review on sustainable building construction, we identified three main focus areas that address different aspects of sustainability throughout the building's life cycle and may indicate more sustainable ways of organising building production, namely, circularity, localisation, and openness, which are explained next.

2.1. Circularity

Transitioning from the linear to the cyclical construction process is deemed necessary for realising sustainable construction [20,32]. Circular Economy (CE) principles are widely applied in the construction industry to achieve Sustainable Development Goals [33,34]. The EU action for CE recommends implementing reuse and recycling methods to enhance the circularity of building materials and wastes [35]. Such methods, like the repair, reclaiming, and repurposing of building materials and components, aim to increase resource efficiency by retaining product value [17,36] while reducing waste and demand for energy consumption and new material inputs [16,18,37]. Indicatively, reusing building components three

times can lead to a 60% saving [38]. However, when material recycling is highly energy intensive or used for applications of lower value than the material's initial purpose, a process known as downcycling [39] may contribute negligibly to circularity [17,40,41]. Selective disassembly and selective demolition are methods that can facilitate the effective reuse of building components and materials [42–47]. The former means that building components can be reclaimed, reused, and maintained throughout the building's life cycle [46,47]. The latter refers to the separation of construction waste on site [42].

The design phase of building construction is decisive in optimising the building's environmental performance and the effectiveness of circular practices [48–51]. Design-embedded modularity appears to be a popular approach to effectively implementing CE principles in building construction [52–54]. More specifically, a modular building consists of independent components (modules) planned for selective disassembly [46,47,55–58]. Thus, modularity enables circularity because independent building components can be easily replaced, repaired, and rearranged without damage [57]. It also empowers people to participate in the construction process because modules can be examined independently, allowing for distributed problem-solving processes and boosting innovation in production [55,59]. Limited studies have been carried out proving that modular buildings present better life-cycle performances when compared with identical conventional counterparts [27,60–62].

Sustainability provides a broad and diffused framing and agency and holistically treats the three dimensions—environment, economy, and society at large [63]. Additionally, research indicates that CE stresses the economic and environmental benefits of less resource depletion and pollution [63,64]. As a result, circularity is a vital element for sustainable building construction, which, however, alone, cannot ensure sustainability. More holistic approaches should be applied to assess buildings, illuminating diverse aspects of sustainability in building construction over the entire life cycle [27].

2.2. Localisation

In the pursuit of integrated sustainable building practices, localisation emerges as a prominent direction, encompassing the construction and operational stages of a building's life cycle. Although the construction industry is dependent on industrial cement concrete and global value chains, and prioritising labour cost reduction, various forms of localisation address the environmental footprint and social impact of the current trajectory [3,65–67]. Characteristically, the sector is responsible for the depletion of approximately 60% of the natural resources annually (e.g., sand, gravel, and water), primarily to cover the global demand for cement and steel—70% and 30%, respectively [12,50,68]. Nevertheless, cement concrete remains a dominant and relatively affordable choice mainly because the environmental costs associated with its production are externalised and, hence, excluded from pricing [66].

Introducing alternative materials to replace industrial cement and improve the performance of building components is at the centre of efforts towards sustainable building construction. Such materials (e.g., geopolymers) aim to mitigate the exploitation of depletable natural resources and reduce embodied carbon, solid waste production, and domestic energy consumption [69–71]. In the context of the CE, emphasis is laid on the utilisation of industrial side streams and waste, recycled materials (e.g., plastics), and construction and demolition waste (CDW) [71–76]. Similarly, the use of agricultural residues (agro-waste) and other bio-based materials is popular [67,77–83]. However, to further enhance the environmental performance and affordability of buildings, particularly for low-income households [22], emphasis is placed on developing strategies aimed at utilising locally available resources and at locally manufacturing building materials/components [22,31,52,79,84–91]. In addition to the aforementioned advantages of alternative materials, utilising local resources, such as abundant raw materials, flowing secondary materials, and locally grown biomaterials (e.g., hemp), can foster a strong connection between construction and the

agricultural sector and local waste management, contributing to the implementation of CE schemes and the reduction of construction costs [22,31,52,79,84–86,88–91].

Additionally, training a local workforce and involving local residents in manufacturing, building, and maintaining materials, components, and buildings creates employment opportunities favouring local economies and the development of a sustainable career for local construction workers [21,31,67,79,85,92]. Relevant research has shown that organisations and employees serving their community are more productive and offer higher-quality services benefiting all stakeholders [92]. Furthermore, establishing a local community at work fosters local resilience by promoting independence from material and technology imports and enables the advancement of the local knowledge/skill capacity and the utilisation of existing local construction knowledge [22,31,79,85,93,94].

In summary, the local context (e.g., climatic conditions, resources, workforce, and land tenure) plays an important role in devising sustainable and affordable building practices that meet region-specific needs and demand for buildings [95,96]. Localising different phases of the building's life cycle, from material sourcing to construction waste management, and the engagement of the local community can help address socio-environmental impacts of the current situation. Further research and institutional support are required, though, to assess the performance of such localisation-oriented efforts in the long run and to introduce them as viable alternatives in the current market [31,79]. Last but not least, the involvement of local governments is pivotal for effectively assessing the availability (region-wise) of local resources and monitoring material flows and waste, as well as facilitating local supply chains and CE strategies [96,97].

2.3. Openness

Openness emerges as another pivotal attribute of sustainable and affordable building construction [98], addressing the challenges associated with conventional construction practices, such as limited collaboration, lack of transparency, and unsustainable material choices. Theoretical frameworks, such as the Open-Source Movement and the Circular Economy Principles, underpin the concept of openness in building construction. In this context, openness refers to transparency regarding the building's life cycle and denotes accessibility to information, knowledge resources, tools, and processes through which a building is designed, built, demolished/disassembled, and assessed in terms of its sustainability [99,100]. Essentially, it involves sharing information about designs, materials, building methods, etc., as digital commons through the internet [101], while design tools and physical production infrastructures, such as factories, makerspaces, and hardware equipment, can also be open-source and shared [58,102].

Relevant research on initiatives employing open-building practices has demonstrated the socio-environmental benefits of openness in building construction [58]. More specifically, the active and collective participation in building development, improvement, production, and maintenance are promoted through open designs, fostering sustainability in building construction [103], and safeguarding the right to housing [7]. Openness allows local communities, organisations, individuals (e.g., designers, engineers, producers, and users), and governments to autonomously monitor, study, and participate in the building process while being supported by a global knowledge network [104–107]. In that sense, open-building practices enable knowledge exchange and collaboration in synchronous and asynchronous formats, both locally and globally, promoting cross-sectoral and trans-regional cooperation.

Implementing openness in building construction poses challenges, such as intellectual property issues or standardisation difficulties and resistance from traditional construction stakeholders. Despite these challenges, transparency through openness in the building's life cycle (e.g., supply chains and labour conditions) facilitates the application of evidence-informed life-cycle sustainability assessments and the evaluation of alternative solutions [24]. This aligns with net-zero objectives and the effective management of the building's life cycle [108,109]. Furthermore, keeping the design open for others to

access and use is usually the most inexpensive solution, with various benefits for both the innovator and users [110–112].

The importance of collaborative knowledge-sharing practices that improve design performance has also been stressed [113]. Such practices could be supported by integrating project participants, commonly understood design objects, and geographically separated designs to achieve the best design [114]. In particular, design integration and a shared understanding between participants in building construction have been reported as key enablers for optimal design performance and project success [115,116]. Also, using open-source codified databases could catalyse the creation of a common language for sharing building components [23].

Finally, the term Open Construction Systems (OCSs) has been used to grasp the concept of open processes in building construction, allowing for an ecosystemic perspective of buildings as complex systems [98]. The design principles of OCSs endorse sustainable material choices and modularity, alongside open sharing and other open-source values. In fact, global sharing and local manufacturing are key points in such initiatives. More specifically, the WikiHouse and the Open Building Institute constitute two examples that fall under the umbrella of OCSs. In this regard, they exemplify how continual innovation enabled through open sharing can generate exponential advancement by building on others' contributions or proposed iterations. The diversity of participants' backgrounds especially brings about diverse contributions; and, hence, such communities become highly innovative [117]. In this context, openness that permeates all the phases of building development has been identified as a pivotal attribute for reducing environmental impacts and enhancing social benefits [98,104].

3. Materials and Methods

The aim of this study is twofold: i. to compare the ecological impact of circularity-oriented construction buildings (based on polymer concrete) versus conventional (cement concrete) buildings of identical sizes and shapes and ii. to critically assess how initiatives like Polycare could enhance their environmental benefits, while scaling their social impact [118]. The latter assessment was based on the desk research of global initiatives working on sustainable construction and unstructured interviews with key stakeholders from Polycare. These interviews were informal and open-ended, allowing the interviewees to express their thoughts freely and provide detailed insights into their goals, practices, challenges, and future plans. The interviews were conducted via video conferencing and lasted approximately 60 min. Figure 1 illustrates the research methodology that was adopted.

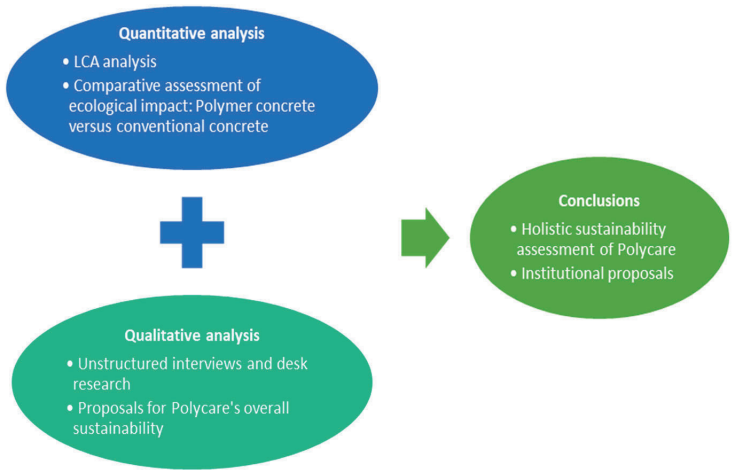

Figure 1. Summary of the methodology.

First, we evaluate the environmental footprint of the Polycare construction system by applying the Life-Cycle Assessment (LCA) methodology, a well-established approach to deal with the quantification of the life-cycle environmental impacts of technologies [109,119–122]. Life-Cycle Assessments, according to DIN EN ISO 14040 [123] and DIN EN ISO 14044 [124], are scientific methods to evaluate products, processes, or services with regard to their environmental impact over the entire life cycle ("from the cradle to the grave"). This encompasses all the stages from raw material exploration and supply, processing, distribution, and use to recycling, reuse, and disposal. LCA enables the quantification and objective assessment of anthropogenic environmental influences occurring during the life cycle. This methodology is instrumental in identifying weak points in a product's or process' environmental characteristics along the process chain, making ecological optimisations, comparing alternatives, and supporting decisions made between alternative processes and routes. Consequently, LCA serves as an important planning and decision-making tool and can also be employed as an information basis for marketing purposes (e.g., by a company advertising its products' environmental compatibility).

According to the DIN standards, the LCA procedure consists of four phases (Figure 2) as follows:

- Objective and Scope Definition: This initial phase involves defining the objective and scope of the study, which includes determining the system boundary and the level of detail. These elements are contingent on the subject and the intended application of the study. Additionally, the functional unit and spatial and temporal limits of the system are established. The functional unit, as defined by DIN EN ISO 14040 [123], is the quantified benefit of a product system utilised as a comparison unit/reference basis;
- Life-Cycle Inventory (LCI) Preparation: This phase involves quantifying the input and output flows (energy and mass flows) throughout the entire life cycle;
- Impact Assessment: This phase entails quantifying the potential effects of the material and energy flows on the environment in the impact categories defined at the beginning;
- Evaluation: This final phase involves interpreting the results, making conclusions and decisions, or deriving recommendations for further action.

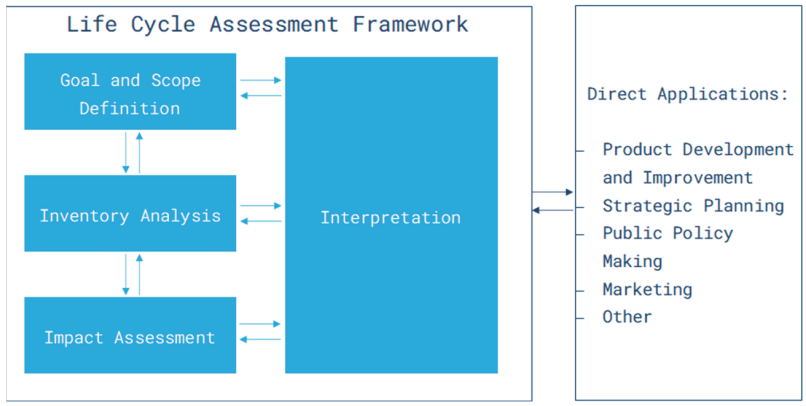

Figure 2. Phases of a life-cycle assessment according to DIN EN ISO 14040.

Herein, different functional units are discussed. On the one hand, the production of (polymer) concrete was comparatively assessed cradle-to-gate, i.e., from the cradle (exploration of the raw materials) to the factory's gate. Initially, the recipes were compared on a mass basis, excluding the subsequent process steps. Further, the functional unit was set to a 1 m^2 wall. The basis for the evaluation is the comparison of Polycare construction elements with coated polystyrene insulation filling to conventional concrete blocks with a plastered thermal insulation system (polystyrene insulation panels) that have the same thermal insulation effect and ventilation heat losses. This makes aspects such as energy

demand negligible in the use phase. On this basis, a simplified life-cycle assessment is permissible. Although this approach does not provide a complete ecological picture of the systems, it clearly highlights different ecological effects.

A comprehensive comparison of polymer concrete to conventional concrete was conducted within a cradle-to-grave framework, referencing a construction project in the South African region and considering a typical Polycare standard house. Only differences (processing steps, materials, service life, disposal aspects, etc.) in the individual life phases were considered. Components, such as windows, doors, roofs, plastering, intermediate slab/concrete ceilings, and paints, were assumed to be similar in both cases and, therefore, were not considered. The mortar, foundation, and a 20% overproduction in cement, in the case of the cement concrete building, were assumed as, typically, more concrete had to be provided owing to waste, scrap, grinding dust, or excess production. The investigation time frame was 50 years, corresponding to the assumed service life of a polymer concrete building in arid, subtropical conditions. Under these climatic conditions, the lifetime for a cement concrete building is around 25 years and 50 years for a Polycare building if adequately maintained after 25 years (e.g., new plastering). However, the foundation in the case of a cement concrete building was assumed to last 50 years and that at the end of life, the building materials would be dismantled, shredded, and deposited in landfills, with comparable expenses for both buildings. Mineral building materials are considered as non-hazardous waste and may be disposed of in building debris landfills or used as filling material or hardcore. It was assumed that 100% of the polymer and 30–100% of the concrete could be used as new recycling materials. If the reuse of building materials is considered, only polymer concrete can be completely recycled in the same life cycle and used as fully functional polymer concrete again, while conventional concrete is often used in secondary ways (other life cycles, e.g., used as a sub-base foundation). This would probably result in further advantages for polymer concrete, which were not considered in this study owing to a lack of data on the demolition and processing of both concrete types.

The energy and material flows required for the LCI of the polymer concrete formulation were provided by Polycare Research Technology GmbH. The life-cycle inventory data for conventional concrete (unreinforced normal concrete based on CEM) were sourced from the ecoinvent database. Where data were unavailable, life-cycle inventory data were substituted or modelled as far as possible. This procedure was followed in our case and used to establish LCI data for LCI databases [124]. Generic datasets on energy and water consumption, reaction and recycling rates, infrastructure, transport routes, and waste strategies were utilised. Although mass flows of less than 1 wt.% relative to the mass of the desired output were present within the scope of the study (e.g., organometallic catalysts acting as accelerators), no flows of a considered process were cut off because they were of interest for the entire life-cycle assessment. As far as possible, the materials supply in the countries of origin specified by Polycare, including corresponding transport processes to the next processing step, was considered.

The material and energy flows were modelled using GaBi TS v8.7 software, integrating inventory data from the ecoinvent database for raw materials, energy, or transport processes. The emission factors of all the materials, energy sources, and transport processes were based on the ecoinvent database. The impact assessment was carried out according to ReCiPe 2016 v. 1.1 [125,126] using midpoint indicators at the hierarchic level. Eight impact categories were considered: climate change (also referred to as global warming potential), consumption of abiotic resources (fossil depletion), freshwater ecotoxicity, metal depletion, human toxicity, terrestrial and freshwater ecotoxicity, terrestrial acidification, and land use. These impact categories were selected as they were assumed to be decisive indicators with regard to political, entrepreneurial, and social interests in the context of the construction industry. The effect categories were not weighted.

Nonetheless, the lack of access to LCA data on the demolition and processing of the examined buildings, combined with focusing on specific impact categories, may render the LCA method reductionist. The analysis is limited to using a certain set of indicators and

building stages. Thus, considering the need for comprehensive approaches to sustainable construction, integrating qualitative tools to critically review the LCA results, and providing a more holistic sustainability assessment are important [24,127,128]. For this reason, the resulting socio-environmental benefits of Polycare are critically discussed in Section 5.2.

4. Case Study: Polycare Construction System

The Polyblock system from Polycare is an innovative construction system developed by Polycare Research Technology GmbH in Germany, aimed at providing affordable and sustainable alternatives to traditional cement concrete. It leverages locally sourced natural materials and industrial residues in a circularity-oriented approach. The company offers a comprehensive business package to potential investors (private, cooperatives, communities, etc.) interested in establishing a local factory. The package includes the manufacturing infrastructures, a customised machine for Polyblocks, design software, knowledge transfer, local workforce training, and marketing support for building Polycare structures locally.

Notably, Polycare Research Technology GmbHis not the owner of the physical factories but receives a licence fee per ton of blocks produced in each factory. So far, only private investors have initiated Polycare factories, with operational sites in Namibia and Germany, and potential expansions in the EU, African countries, and South East Asia. The reason for focusing on developing African countries is strategic, given their rapid urbanisation, abundant desert sands that are appropriate for producing polymer concrete, and expedited permit acquisition for building Polycare structures. For instance, obtaining a material permit for polymer concrete took six months in South Africa compared to seven years in Germany.

4.1. Materials

Polycare structures are made of Lego-like stackable blocks, the Polyblocks. These blocks consist of a polymer concrete shell and a thermal insulation core made of expanded polystyrene or mineral wool (Figure 3A). Polymer concrete is composed of 88% filler materials and 12% binders. The fillers are flowing local materials, including desert sands or (industrial) secondary raw materials (e.g., foundry sand, slag, tailings, building rubble, or overburden). These materials are mixed with the resin and then cast into moulds. The binder is unsaturated terephthalic polyester resin containing up to 38% recycled polyethylene terephthalate (PET) (e.g., recycled bottles or industrial rejects), provided by a partner company. The accelerated polymerisation process does not require an external energy supply.

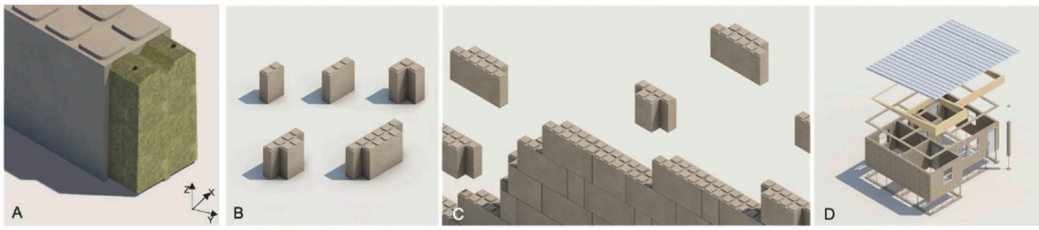

Figure 3. Modular design of the Polyblock system; (**A**) section of a typical Polyblock, (**B**) five different types of Polyblocks, (**C**) a straight wall configuration built with different Polyblock types, (**D**) assembly of a typical rectangular Polyblock building.

Compared with cement concrete, polymer concrete has superior physical properties. Its long lifetime is expected to exceed 100 years owing to its high durability and weathering resistance. Polycare's polymer concrete has a mechanical strength that is 4–5 times higher than that of cement concrete, with a compressive strength (σ,c) of 90–130 MPa and a flexural strength (σ,f) of 20–40 MPa, depending on the composition of the polymer concrete mix. Hence, only 20% of the Polyblock's volume is polymer concrete, which forms the

outer, load-bearing shell of the Polyblock. The inner core of the Polyblock is thermal insulation, i.e., expanded polystyrene (EPS) or mineral wool (Figure 3A). Consequently, the overall material input is reduced by approximately 80%, resulting in lightweight blocks that have a maximum specific weight of 18 kg per Polyblock. A completed Polyblock wall has a compressive strength of 4.5–5.0 MPa and thermal insulation properties of U = 0.4–0.55 $W/m^2 * K$, depending on the insulation material that is used.

Regarding further building performance requirements, the Polyblock wall system fulfilled the requirements of the fire resistance classes REI 60 in terms of load-bearing capacity, room closure, and thermal insulation, depending on the plaster that was used (according to DIN EN 13501-2:2010-02 [129]). Polymer concrete, as such, is classified in building material class B1 (flame retardant) according to DIN 4102 [130]. The sound insulation of polymer concrete is equivalent to the sound insulation of cement concrete, which corresponds to a very good sound insulation.

Simulation tests for the durability performance of Polyblocks (e.g., in a climate chamber) showed no change in mechanical or physical properties within the simulation for 30 years. Polyblocks are expected to retain their full properties for >80 years, which would allow for multiple construction cycles.

At the end of the building's lifecycle, the Polyblocks can be reclaimed, crushed, and separated into their constituent materials. For example, it is possible to separate the insulation core from polymer concrete and obtain different grain fractions through sieving. Additionally, more advanced technologies, like electro-dynamic fragmentation, can be used to separate aggregates from the binder. Although obtaining the raw materials (e.g., fillers, resins, and the insulation core) in their original form may not be feasible, they can be repurposed as aggregates for producing fresh polymer concrete.

4.2. Design

Polycare has developed a proprietary customised design software called Polybuilder to translate (rectangular) buildings into Polyblock structures through an optimisation algorithm. The software converts architectural plans into 3D models incorporating the Polyblocks' specifications and structural requirements, while calculating the optimal use and composition of Polyblocks. The aim is to produce efficient solutions using the largest block type. In addition, Polybuilder provides building plans for on-site assembly and disassembly, along with all the relevant information for the downstream processes (i.e., production, logistics, and delivery), thus facilitating environmental footprint estimations.

Modularity is a design-embedded attribute of Polycare enabled by the Polyblocks. There are five differently dimensioned and shaped Polyblocks (excl. special blocks) that allow the construction of various rectangular wall structures. These "micro-modules" (Polyblocks) have dimensions of 200 mm thick (Figure 3A, x-axis), 200–600 mm long (Figure 3A, y-axis), and 300 mm high (Figure 3A, z-axis). Polyblocks are stacked and statically fixated with threaded rods, facilitating easy assembly, selective disassembly, and reassembly (Figure 3C,D). This allows the removal, repair, and replacement of damaged blocks or storage of blocks for future reuse without material destruction.

4.3. Manufacturing and Assembly

Constructing Polycare structures does not require specialist knowledge, heavy machinery, or significant heat and energy consumption. Solid walls are built by lining up the Polyblocks, stacking them by hand, and clamping them together with threaded rods, without using glue or mortar jointing. Threaded rods are also used to fasten Polyblock walls to the ring beam (typically constructed from wood), which is, in turn, connected to the roof framework (Figure 3D). The ground bar, serving as the foundation for the wall, can be positioned atop various foundation types or directly on compacted ground. A practical, low-impact solution is recommended, like a screw-in foundation that can be easily disassembled. Other structural components, like doors, windows, and additional facade elements, can be integrated into the overall structure in a conventional manner.

Polyblocks are manufactured in local micro-factories using customised extruder machines through a straightforward casting and curing process. Polycare Research Technology GmbH supplies these factories globally and collaborates with a partner company specialising in extruder machines for polyester resins. They have jointly developed the current machine, which fits into a shipping container and can produce enough Polyblocks to build a 60 m^2 house in one day. This production rate equates to one house per 8 h shift and generates 30 local jobs at a cost of approximately 25,000–30,000 EUR.

4.4. Future Improvements

Polycare is actively working on developing a next generation Polyblock system; a geopolymer-based masonry system containing a completely inorganic binder. This development aims to address the resin's significant environmental impact and to decouple from unpredictable oil-price fluctuations, which may impact the affordability of Polyblocks. Thus, the 62% of the polyester resin that is not recycled PET will be replaced. Moreover, the geopolymer concrete recipe aims to utilise up to 99% of secondary raw materials (currently between 60–90%). Compared with polymer concrete, geopolymer concrete will require less primary raw material input and produce fewer CO_2 emissions and non-hazardous wastes, which can be safely stored in building debris landfills.

Furthermore, research is being conducted to explore ecological and locally sourced alternatives for insulation materials, such as locally produced hemp. This initiative aligns with regional development strategies that seek to connect the construction and agricultural sectors. Studies on industrial hemp indicate its potential for better environmental performance and its ability to complement the circular value chain approach of Polycare [131–133].

Lastly, Polycare is investigating leasing and renting models for Polyblocks to facilitate reclamation at the end of their lifecycle. However, implementing such experimental models presents challenges due to limited financial support from private banks or other sources.

5. Results and Discussion

5.1. LCA Results

The LCA results indicated that the ecological sustainability of polymer concrete is largely influenced by the resins that are used, contributing to up to 90% of the ecological impact, depending on the recipe and impact category. Meanwhile, the contributions from transport, infrastructure, solvent supply (for machine cleaning), or electricity were found to be negligibly low.

When compared to cement concrete in terms of mass, i.e., on the basis of a functional unit of 1 kg, polymer concrete does not exhibit any ecological advantages, mainly owing to the resin's environmental impact. However, the results are different when considering the physicochemical properties of polymer concrete, such as low density, low specific weight, and high compressive and bending tensile strengths. In this case, polymer concrete offers ecological advantages comparable to those of cement concrete, as the material requirement per 1 m^2 of wall surface is reduced by 80% (Figure 4).

Moreover, additional ecological benefits are observed when taking into account the construction and disposal phases. Polymer concrete outperforms cement concrete in all the assessed impact categories (Figure 5). The key factors affecting this result are (i) a significantly longer service life compared with that of cement concrete, especially under harsh climatic conditions, (ii) no waste during the construction phase, and (iii) the absence of standard building sand [134].

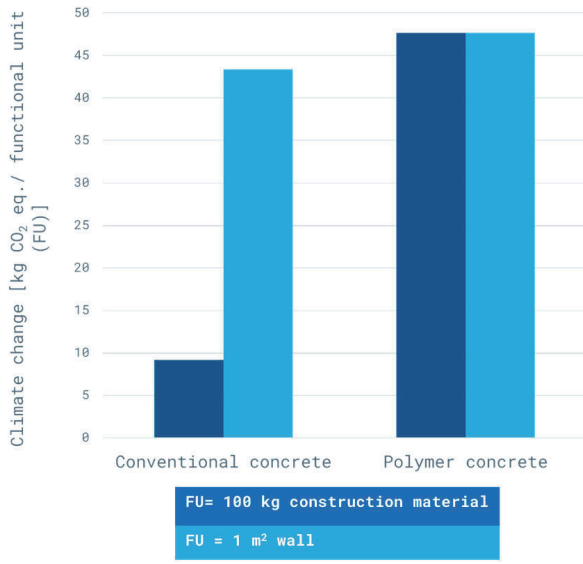

Figure 4. Comparative assessment of the ecological effects (scaled) of the production of 100 kg (dark blue bars) and a 1 m^2 wall (thickness of 0.2 m) (light blue bars) of cement concrete and polymer concrete for the impact category of climate change.

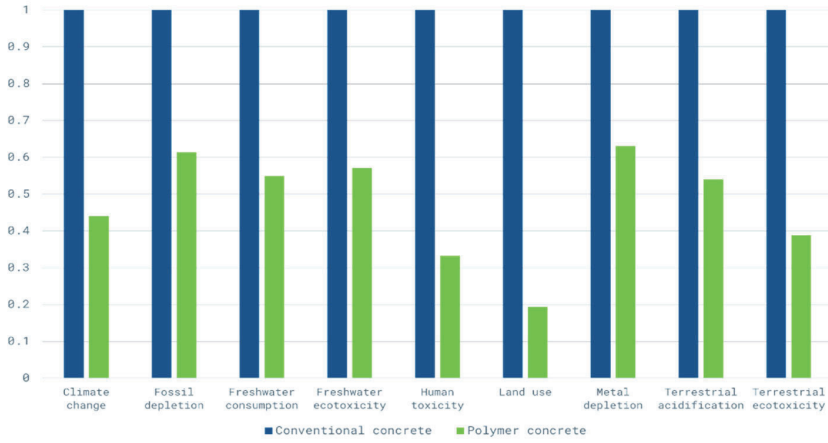

Figure 5. Comparative assessment of the ecological impacts (scaled) of the construction, use, and disposal phases of a conventional concrete-based (unreinforced) and a polymer concrete-based building. Note: highest (worst) values are normalised to 1.

An assessment of environmental performance requires the absolute or comparative measurement of a range of indicators. Contribution to global warming is the most impactful for climate change. The results of the climate change category (Figure 6) show that a polymer concrete building has a reduced impact on global warming by approximately 60% throughout its life cycle, compared to a conventional concrete structure of an identical shape and size.

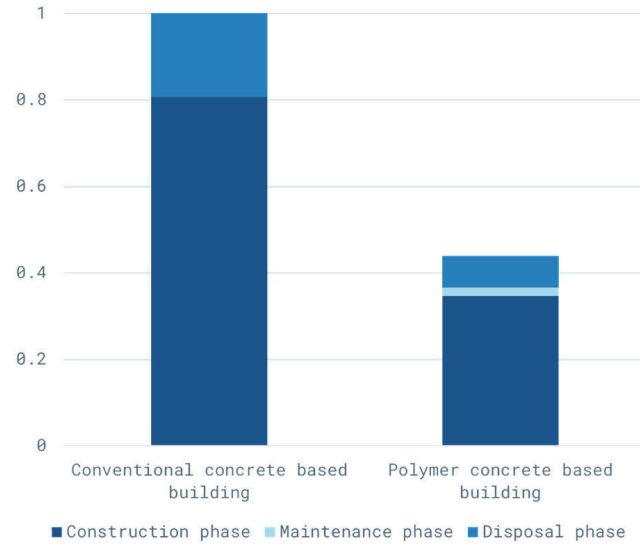

Figure 6. Comparative assessment of the global warming potential of a solid concrete-based building and a polymer concrete-based house, considering the life-cycle phases of construction, maintenance, and disposal.

To sum up, considering the significant contribution of cement production to anthropogenic CO_2 emissions, polymer concrete buildings show great potential in reducing the ecological footprint of the construction sector.

5.2. Discussing the Sustainability Potential of Polycare

This study revealed that Polycare's buildings, combining the advantages of polymer concrete with design-embedded modularity, perform better than a conventional counterpart across all eight impact categories from an environmental aspect. However, it is crucial to recognise that this achievement alone may not suffice to attain sustainability within planetary boundaries [61]. In addition, the LCA method has been criticised for being reductionist, as explained in Section 3, and, thus, insufficient for a comprehensive assessment of sustainable construction. For instance, it overlooks socio-economic dimensions of sustainability. In this subsection, we attempt to critically discuss the sustainability potential of Polycare as a non-conventional building system by emphasising interviewees' statements and key literature findings regarding sustainable transitions in building construction.

The primary goal of Polycare is to develop sustainable and affordable building solutions that contribute to local circular economy schemes. The stakeholders expressed a strong commitment to environmental sustainability, local economic development, and community empowerment. In this direction, Polycare necessitates and facilitates the establishment of regional/local supply chains and a trained local workforce, having adopted practices that align with circularity and localisation, as described in Sections 2.1 and 2.2, respectively. Polymer concrete (and potentially future geopolymers), the design-embedded modularity of Polyblocks, and the ability to establish a local workforce allow for the utilisation of locally sourced materials, substitution of conventional building sand, and contribution to circular economy schemes, cross-sectoral collaborations, community empowerment, and autonomy.

Polyblocks are manufactured locally, considering biophysical conditions, local capacity, and needs. The manufacturing process as well as the material are under constant optimisation and adaptation. The polymer concrete recipe is adaptable to different contexts, regarding the availability of material resources, industrial residues, or recycled materials. Furthermore, the modular design of Polyblocks enables selective disassembly, which

can lead to great environmental benefits, as described in Section 2.1. Hence, Polyblocks can be reclaimed, repaired, and reused at the end of their life cycle. In other words, the design-embedded modularity of Polyblocks can foster the effective implementation of CE principles in building construction [53–55]. Similarly, given that manufacturing and building with Polyblocks are relatively easy and do not require expert skills, it is possible to establish distributed networks of Polyblock technicians and further support local economies and the community's autonomy by creating a local workforce; yet, the current infrastructure (factory and customised extruder machine) and resins are imported. Also, Polycare oversees the reclamation or disposal of Polyblocks post-use and profits from local Polyblock production. Thus, although Polyblock manufacturing and building construction are localised, some crucial operations of Polycare remain external to local contexts.

In this light, we pose that Polycare could further leverage the benefits of localisation and circularity by incorporating different degrees of openness regarding software, hardware, and design. In fact, using open-source software to customise designs for the optimal use of Polyblocks is one of Polycare's future goals. Moreover, Polycare could share the knowledge required to manufacture the extruder machine locally instead of providing it as a part of the factory deal (see Section 4.3). This approach could decrease logistic and environmental costs, limit technology imports, and further support local participation, capacity building, and autonomy. By adopting open-design practices, local community networks could benefit from a global knowledge-exchange network, fostering innovation regarding Polycare's adoption and adaptability to diverse local contexts. In that sense, global sharing could enhance the local manufacturing capacity for Polycare buildings, partially boosting the local economy while facilitating the widespread adoption of this building system.

Various established initiatives have demonstrated the socio-environmental and economic benefits of such open-source software, open-hardware, and open-design approaches [7,59,104]. Open practices enable initiatives active in building construction to innovate effectively in the current market and augment their social impact through collaborative efforts. More specifically, open sharing facilitates continual innovation and, subsequently, exponential advancement by leveraging the diverse contributions of others [117]. However, ensuring the viability of initiatives that embrace openness requires the development of business models and frameworks, which are currently in progress and vary across national contexts. The absence of frameworks or other kinds of institutional and financial support impedes the adoption of open practices, particularly by businesses that currently rely on patented technologies, such as Polycare.

In this light, institutional support at national and international levels is necessary to address legal complexities or the absence of regulatory frameworks [98] and to facilitate investments in alternatives to cement concrete [119]. For example, Polycare currently faces legal obstacles in acquiring permits for innovative building materials and financing/implementing the rental business model for Polyblocks (see Section 4.4). From that perspective, institutional support is fundamental to overcome legal and economic challenges and to stimulate a transition to open-source practices.

Furthermore, public investment could also promote the adoption of sustainable practices in building construction. To this end, public–private partnerships could be established. In Polycare's case, for example, public investment could support the research and development of geopolymers, addressing the drawbacks of polymer concrete, such as dependency on fossil fuels and oil-price fluctuations (see Section 4.4). Additionally, different fees could be applied for community-led initiatives, such as cooperatives, social enterprises, and open-source communities, that adopt or invest in alternative approaches. As indicated by the interviewees, local communities could be empowered to invest in Polycare factories, enhancing the social impact of this building model and counterbalancing profit-led investments by private actors. Moreover, public rewards (e.g., tax incentives) could incentivise private companies to adopt ecological and open practices without jeopardising their economic viability. In Polycare's case, public investment could also facilitate the implemen-

tation of circularity-oriented rental models (for example, the one proposed for Polyblocks), which are challenging to fund via private banks (see Section 4.4). Furthermore, public investment is crucial for connecting different sectors, locally and regionally, with numerous mutual benefits. For instance, linking the agricultural sector with the construction sector by utilising agricultural residues to produce sustainable building bio-materials.

The interviewees stressed the importance of partnerships with institutions and entities in the construction industry to advocate for the necessary support in dealing with the aforementioned legal and financial challenges. Through such collaborations, they claimed to have strengthened their political voice and, to some extent, expedited the typically protracted building permit process and legal obstacles. In that sense, joint efforts can encourage policy changes relevant to different national/regional contexts. Also, as demonstrated by initiatives employing open practices [102,104] to boost their scalability and social impact, a strategic plan for companies, like Polycare, could include establishing local, regional, global, and cross-sectoral partnerships. Research has indicated that combining top-down, institution-driven organisations (e.g., municipal/local governments) with bottom-up, society-driven ones (e.g., communities, companies, and citizens) is essential for fully implementing circularity and benefiting all the parties that are involved [135–137]. By uniting diverse actors, the strategic planning of buildings' life-cycle management, identification of local demand, and organisation and distribution of production networks can be facilitated, enabling multi-level innovation [136–139]. In these ways, a more sustainable—circular, local, and open—construction ecosystem could evolve, as summarised in the subsequent figure (Figure 7).

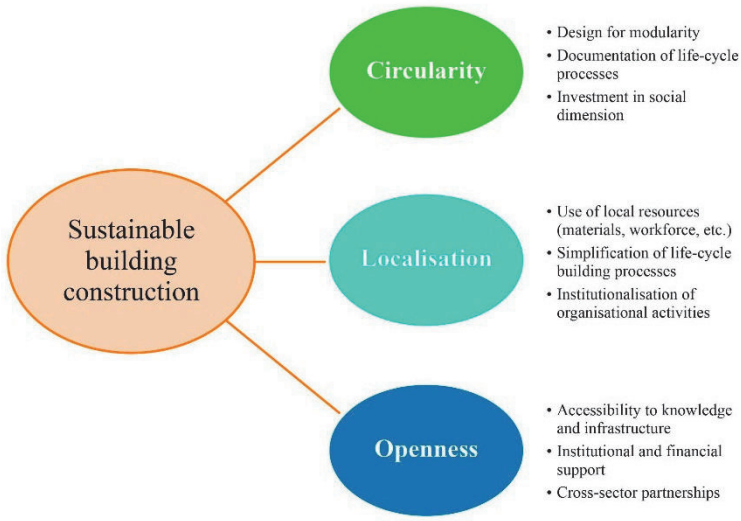

Figure 7. Critical issues for enhancing sustainable building construction.

6. Conclusions

In a plurality of perspectives towards sustainable building construction, this study focused on "Polycare", a novel modular construction system using polymer concrete blocks. Employing both quantitative and qualitative approaches, this case study aimed to (i) contrast the environmental impact of polymer concrete-based structures with that of conventional concrete-based structures of identical dimensions and (ii) suggest ways to enhance the sustainability of such initiatives.

The LCA results verified the environmental advantages of polymer concrete over conventional concrete, when considering the physicochemical properties of the former. That is mostly attributed to the 80% reduction in material required per square metre of a polymer concrete wall surface. Additional benefits include the durability and reusability

of polymer concrete blocks and the substitution of traditional building sand. Moreover, we highlighted the significance of Polycare buildings' design-embedded modularity as a key feature to facilitate circular processes. Furthermore, drawing from the literature and interview insights, we posited that the integration of circularity, localisation, and openness is fundamental for creating sustainable and affordable building solutions, particularly for housing.

The Polycare construction system is already aligned with circular and local practices. However, further action has been suggested to better align with diverse local contexts, support local economies/communities, and facilitate cross-regional cooperation. Suggestions referred to exploring ways for reducing existing imports in terms of manufacturing and materials and integrating openness. Despite recognising openness as a critical factor for enhancing sustainability in a broader context, Polycare has yet to embrace open practices. In this direction, we call for strategic collaborations, institutional support, and public investment to facilitate the sustained operation of such novel initiatives within the existing market, creating space for the development or adoption of non-conventional building practices and business models to flourish.

The limitations of this study include the inherent disadvantages of the Life-Cycle Assessment (LCA) method, which estimates the ecological footprint of a building based on specific data, while neglecting other sustainability dimensions (e.g., social and economic). Additionally, because Polycare is a relatively new market entrant, there is a lack of tangible evidence regarding the entire life cycle of Polyblock buildings, which is estimated to be between 25 and 50 years. Furthermore, the limited number of operating Polyblock factories provides scarcesolid evidence on how the Polycare system would function across a range of local contexts and legislative frameworks. Lastly, despite that Polycare is exploring geopolymers to address conventional polymer concrete limitations and considering biomaterials for thermal insulation, the sustainability potential of such materials/components remains untested under real circumstances.

In conclusion, achieving comprehensive sustainability transitions in the construction sector entails addressing numerous questions beyond the scope of this article. To this end, future research could investigate different contexts and account for differences in the environmental performance of housing projects and institutional structures. Additionally, future studies could examine holistic sustainability assessment frameworks applicable to building construction, accounting for the life-cycle impacts of buildings.

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Article

Beyond Fraudulent Hopes Versus Despair: The Potential Of Commons-Based Technological Futures

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Abstract

This paper explores how the commons foster the construction of an alternative technological pathway premised on a shared vision for a sustainable future. First, I delineate the shortcomings and biases of dominant techno-optimist narratives and advocate for a nuanced understanding of technology. Further, assuming that collective action encourages hope and vice versa, I discuss the potentiality of commons-based institutions as catalysts for systemic changes at both local and global levels. The paper offers a practice-informed perspective, drawing insights from the illustrative case of Tzoumakers — a commons-based grassroots initiative that develops open-source agricultural technology.

Keywords

Commons, Cosmolocal Production, Techno-optimism, Collective Hope, Collective Action

Introduction

Our era is marked by an existential anxiety associated with the multidimensional environmental, social, and cultural degradation linked to neoliberalism. This anxiety finds little solace in Western and Westernised societies, which grapple with a fractured connection to living systems, weakening community bonds, and the assault of rationalisation on spiritual awareness. The lack of effective solutions to address the escalating crisis has reignited a discourse on hope for a more sustainable future (Blühdorn, 2017; Gunderson, 2020; Kleres & Wettergren, 2017; Pleeging et al., 2021; Ojala, 2023; Sangervo et al., 2022).

Technology is pivotal in this discourse, embodying both optimism and pessimism (Huber, 2023). Advanced technology, or in other words, high-tech, is thus viewed either as the panacea for survival or as a poison threatening humans and the planet (Lemmens, 2011). For techno-optimists, high-tech will save humanity from impending environmental catastrophe and alleviate the burdens of human existence (Hui, 2017). However, numerous critiques, accompanied by growing evidence of the destruction caused by the capitalist techno-economic trajectory, show that blind fixation on the possibility of a sustainable and just future mediated solely by high-tech is misleading (Hornborg, 2024). The dominant institutions, which accommodate corporate interests, encourage the uncritical adoption of techno-optimism while impeding alternative pathways (Blühdorn, 2017; Drahos, 2004).

Moving beyond techno-optimism does not mean abandoning hope or denying the potential of high-tech for sustainability. Instead, I discuss a different direction, acknowledging that a reductionist approach to technology fails to address sustainability challenges (Hornborg, 2024; Paulson, 2024). Moreover, it overlooks that the current power structures driving technological progress foster "fraudulent" hopes (Bloch, 1959/1986). Drawing from the discourse on hope, futures studies, and the political economy of the commons, this paper underscores the importance of cultivating awareness of technology (Hui, 2022; Bridle, 2018; Feenberg, 1999) and of the political significance of hope (Lindroth & Sinevaara-Niskanen, 2019). The argument posits that a conscious engagement with technology is essential to enhance people's ability to distinguish harmful hopes from actual possibilities for equitable

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sustainability.

In tackling the challenge of cultivating awareness and encouraging people's agency, the paper explores the potential of developing technology based on the commons. The commons refers to a context-adaptive system of collective self-organisation, governance, and production that prioritises socio-ecological well-being over monetary value (Bollier & Helfrich, 2019; Kostakis et al., 2023a). Based on the idea that action can lead to hope (Kleres & Wettergren, 2017; Ojala, 2023), I conceptualise the commons as an institution that, unlike dominant ones, may help a collective practice of hope to emerge organically from the bottom up, countering the prevailing corporate-driven technological monoculture.

To enrich this conceptual paper, I use a pertinent example of a grassroots initiative called Tzoumakers. The initiative is based in a remote Greek village and is dedicated to developing open-source technology for small-scale agriculture. Tzoumakers serves as an illustrative case study providing insights into an emerging commons-based configuration for technology production. This configuration, called "cosmolocal" production, promotes sustainable and convivial practices for technology development (Kostakis & Tsiouris, 2024). Moreover, the community-oriented work of Tzoumakers provides a practice-informed foundation for exploring commons-based institutions through the lens of hope.

The paper is informed by my dual perspective on the case study as both a practitioner and researcher, following a "pracademic" approach (Rau et al., 2018). Namely, I am an integral member of the Tzoumakers community and an affiliated researcher with the research collective P2P Lab, which played a foundational role in conceiving the initiative. The paper draws from various sources related to the work of Tzoumakers, such as activity reports and meeting proceedings. It also includes subjective observations and interpretations of my participatory experience of the initiative's activities and interactions with other community members. Lastly, my long-standing engagement with the local communities where the initiative operates has further enriched my understanding of the initiative's goals, impacts, potentials and obstacles.

The paper resonates with efforts to bridge social action and academic research,adopting transdisciplinary modes of knowledge production. Moreover, by focusing on the timely issue of technology, the paper seeks to contribute to the literature that explores future possibilities beyond the systemic failures of dominant institutions. Lastly, the paper explicitly supports and advances the scholarship that sees the commons as fundamental to dealing with the problems of the present while collectively building a better future for the next generations.

The remainder of the article is structured as follows: Section 2 introduces the theoretical foundations of the paper, including a critical overview of hope associated with technology, and the commons as an institution of collective action and hope. Next, section 3 presents the grassroots initiative of Tzoumakers to enrich the theoretical overview with insights from a practice-informed perspective. Section 4 discusses pivotal aspects of the alternative technological pathway exemplified by the case study. Lastly, section 5 provides concluding remarks and avenues for future research.

Theoretical Background

On hope and technology: acknowledging the limits of techno-optimism

"Technology will save us all" (Farmer, 2023) is a familiar quote, suggesting that high-tech holds the key to a better, more sustainable future. However, while such a techno-optimist idea opens a window of hope, it may also be deceptive. That is because techno-optimism is currently rooted in narrow, Western views of technology, premised on modernist thought, emphasising mastery over nature and imposition on other cultures (Feenberg & McCarthy, 2023; Hui, 2017; Paulson, 2024). Furthermore, techno-optimism may incorporate biases that require attention when considering the political context of hope (Lacelle-Webster, 2023; Lindroth & Sinevaara-Niskanen, 2019; 2022).

The dominant technological trajectory has been criticised for its historical association with discriminatory systems (i.e., colonial, racial, and gender systems) (Barca, 2020; Irwin & White, 2019; Paulson, 2024). Additionally, in line with the capitalist dogma of economic growth, "Western technology" prioritises monetary profit maximisation over the common good by promoting accelerated innovation and efficiency optimisation (Pansera et al., 2019; Pansera & Fressoli, 2021). However, the intertwining of growth and innovation overlooks the profound

implications of high-tech artefacts and their related processes. This neglect therefore extends to how artefacts are designed, manufactured, used, maintained, and discarded (Giotitsas, 2019). These processes can include excessive resource extraction and energy consumption, labour exploitation, toxic waste, data acquisition, and planned obsolescence (Fraser, 2019; Lange et al., 2020; Kostakis et al., 2023b; Krebs & Weber, 2021; Sovacool et al., 2020).

Furthermore, high-tech has arguably lost its social purpose, leading to various forms of alienation associated with neoliberalism (Brownhill et al., 2012; Huesemann & Huesemann, 2011; Irwin & White, 2019). This shift diminishes human agency and impedes people's ability to comprehend and engage with technology (Drechsler, 2020). Moreover, the planetarisation of Western technology marginalises technological pluralism rooted in diverse cosmologies, epistemologies, and values (Calisto Friant et al., 2023; Hui, 2022; 2023). Similarly, technological globalisation is uncritically accepted without regard to locality-specific nuances and potential power imbalances (Jambadu et al., 2024; Hui, 2022).

The mainstream sustainability discourse (e.g., green growth, ecomodernism) favours the adoption of eco-efficient and "smart" technologies and emphasises the importance of technology transfer for the Sustainable Development Goals (Corsi et al., 2020; Kasinathan et al., 2022; Komatsu & Rappleye, 2023; Managi et al., 2021). Furthermore, this discourse approaches sustainability as a purely technical problem, suggesting that techno-fixes or efficiency improvements can address the deepening crisis (Huesemann & Huesemann, 2011). However, these assumptions ignore high-tech's unpredictable long-term impact and the broader ontological and political context (Hornborg, 2016). In this sense, techno-optimism, anchored in the delusion of technological salvation (Hornborg, 2024), denies the destructive nature of the dominant trajectory and overlooks the inherent complexity of sustainability (Blühdorn, 2017; Dillet & Hatzisavvidou, 2022).

Recognising techno-optimism's myopic perspective does not necessarily lead to techno-pessimism (rejecting hope or the sustainability potential of high-tech). Instead, debunking techno-optimism could offer the grounds for transcending the unconscious fixation on fraudulent high-tech-oriented hopes while encouraging the exploration and development of alternative technological pathways. However, enhancing the capacity to hope for, imagine and develop alternatives requires space for exchange, and experimentation. Next, I discuss how this space can be created and facilitated through the commons.

Commons as institutions of collective hope: moving beyond techno-optimist stagnation

Considering the interweaving of hope into politics (Boucher, 2020; Lacelle-Webster, 2023), techno-optimism aligns with what Drahos (2004) terms "public hope", which is imposed and managed by the state with the support of corporations and scientists. This top-down encouragement of hope aims to maintain the status quo while delaying and limiting social action (Haro, 2010; Drahos, 2004; Lindroth & Sinevaara-Niskanen, 2019). Trust in social and democratic institutions is necessary, though, for the rhetoric of public hope to be effective (Krafft et al., 2023; Stahl, 2019). Despite recent studies indicating a decline in this trust (Merkel & Lührmann, 2021; Van Prooijen et al., 2022), the prevailing belief that there is no alternative to the current techno-economic system leaves us exposed to the passive adoption of techno-optimist preachings.

Before succumbing to despair, however, and beyond disempowering, distracting, or manipulative expressions of hope (Lacelle-Webster, 2023; Lindroth & Sinevaara-Niskanen, 2019), other positive expressions could encourage social agency. As Fard (2023) argues, hope also has a destabilising capacity against established power structures when grounded in collectives rather than individuals. According to Braithwaite (2004), "collective hope" involves a process whereby individuals genuinely and critically share a vision of desired social change, understand and commit to shared goals, and see the possibility of achieving them through cooperation. In this sense, collective hope and collective action are mutually interrelated. As opposed to public hope, collective hope "is owned by the people rather than being imposed from above" (Braithwaite, 2004, p. 129). That is also why collective hope is more often associated with grassroots and non-governmental agencies (Lueck, 2007). Although it is uncertain whether radical changes will ultimately occur, the practice of collective hope mobilises responsible action to counteract the stagnating enforcement of public hope.

Because dominant institutions often nurture false hopes in the interests of powerful elites (even within democratic contexts), Braithwaite (2004) suggests that different institutions are needed to foster collective hope. These "institutions of collective hope" may create space for dreaming and accomplishing the extraordinary without feeling

hopeless about shaping our futures (Braithwaite, 2004). In this regard, I conceptualise the commons as an institution of collective hope that provides a platform for people to cope, hope, and act together.

Institutions broadly refer to interrelated rules, norms, and practices that guide social encounters towards valued goals (Braithwaite, 2004). Commons-based institutions refer to those in which a community self-organises and devices rules and standards to manage shared resources and cooperatively produce goods or take action to deal with contemporary large-scale challenges (e.g., climate change) (Bollier, 2014; Yoder et al., 2022). Beyond monetary profit and exchange value, the commons 'approach prioritises the socio-ecological well-being of present and future generations at local and planetary scales, accounting for the interconnections amongst and within living, social and technological systems (Bollier & Helfrich, 2019).

The commons has been extensively studied from the perspective of small-scale collective institutions for the sustainable local management of shared natural resources — for instance, community forests and fisheries (Ostrom, 2009). More recent is the emergence of commons-based institutions with a simultaneous local and global orientation (Kostakis et al., 2023a). Enabled by Information and Communication Technologies (ICTs), these configurations allow the asynchronous cooperation between individuals, communities, and networks to manage, safeguard and produce a more comprehensive range of resources, goods and services (e.g., data, software, digital archives) (Hess, 2008; Kostakis et al., 2023a; Schismenos et al., 2020). Examples include networks for preserving indigenous seeds or initiatives developing open-source technology (Kostakis et al., 2023b; Mazé et al., 2021). Other studies explore the potential of commons-based institutions to address global challenges, such as climate change and biodiversity loss by enabling collective action where "neither voluntary incentives nor government regulations have been able to deliver effective solutions" (Yoder et al., 2022, p. 52).

There is no blueprint for how commons-based ventures should be created and operated (Bollier & Helfrich, 2019). However, the shared values of justice and ecological stability underpin the constantly appearing initiatives (Kostakis et al., 2023a). In this light, the concept of the commons can be viewed as a universal language not bound by universalist ideologies (Gibson-Graham 2002), which allows for diverse and context-specific ways of governing, producing and living to emerge (Bollier, 2014).

Based on the hypothesis that hope can lead to action and vice versa (Ojala, 2023), commons-based institutions can be seen as institutions that foster collective hope and collective action. Such institutions may help people collectively envision a more sustainable and just future, deal with challenges remaining unaddressed by established institutions, and simultaneously work towards alternative solutions. In the next section, I discuss the case of Tzoumakers, a grassroots commons-based initiative that develops technology for small-scale agriculture. I explain how the community works and its broader vision, and discuss its contribution to paving an alternative technological path.

Case-Study: Tzoumakers

An overview

Tzoumakers is a rural initiative dedicated to developing open-source technologies for small-scale agriculture. The initiative has been operating since 2018 in the remote mountainous region of Tzoumerka in Epirus, northwestern Greece, where the local population largely depends on small-scale and low-intensity agricultural activities. Tzoumakers comprises a diverse, self-organised community of farmers, engineers, designers, makers, and other skilled workers who aim to identify and address local needs, primarily related to agricultural production. The community shares a physical space, a makerspace, where members have access to resources and essential manufacturing equipment to produce technological artefacts. The community is also part of regional and international networks contributing to and being supported by a global ecosystem of knowledge exchange.

Tzoumakers was originally conceived by the P2P Lab research collective, also based in Epirus, Greece, and is the result of five action research projects coordinated by the collective. These projects explored how to achieve local autonomy, sustainability, and knowledge exchange employing a global pool of knowledge commons (Kostakis et al., 2023a). Additionally, the initiative served as a pilot application to test the emerging production configuration referred to as "design global, manufacture local" (Kostakis et al., 2018) or "cosmolocalism" investigating a

collaborative, inclusive and sustainable alternative to production (Schismenos et al., 2020).

Moreover, endeavours with similar goals inspired the creation of Tzoumakers. For example, members of the P2P Lab collective initially studied and established connections with the Farm Hack network in the United States and the L'Atelier Paysan organisation in France (Giotitsas, 2019; Kostakis et al., 2023a). As mentioned by Kostakis et al. (2023a), these endeavours embrace an open-source philosophy and recognise the commons as the unifying factor that fosters global connections among like-minded individuals and groups involved in agriculture and other production sectors.

The starting point for the creation of Tzoumakers was to support local farmers who face significant difficulties in finding appropriate and affordable tools for their needs, capacities or sustainability-related choices (Pantazis & Meyer, 2020), while exploring the potential of cosmolocal production. Nevertheless, Tzoumakers share a broader vision. That is the establishment of similar communities and makerspaces in both urban and rural areas to reconnect society and technology (Tzoumakers, 2024). Tzoumakers also contributes to the goals of cosmolocalism to raise awareness about the potential of post-capitalist futures premised upon the values and principles of the commons (Schismenos et al., 2020).

So far, Tzoumakers have developed various tools and machinery tailored to the specific needs of local farmers and farmers from other regions. Documentation of these technological solutions as Open-Source Hardware (OSH) (Hannig & Teich, 2021) is also underway. Simultaneously, the makerspace serves as a hub for locals to repair their equipment and access or borrow tools for everyday needs. Additionally, through various open educational and outreach events, Tzoumakers 'impact has gone beyond developing technological solutions for farmers. In fact, the community action has contributed to establishing and reinforcing of Social and Solidarity Economy (SSE) enterprises, strengthening an emerging local/regional social economy ecosystem. Moreover, strategic partnerships between the Tzoumakers 'community and similar initiatives, activists, experts and researchers have facilitated participation in local, national and international networks, fostering continuous interaction between scientific research and grassroots action towards change. Lastly, despite the remote location, Tzoumakers have attracted attention from media outlets, organisations and individuals alike, promoting both their efforts and the region, opening space for international academic tourism and invigorating the local economy.

Since September 2023, the initiative has entered a transition phase into the hands of the local community, following an extensive period of public deliberation that occurred both asynchronously and in person. The discussions involved local stakeholders (i.e., members of the Tzoumakers community, local residents, government officials, and representatives of cultural organisations) and members of the wider community. Through this process, pivotal decisions about the future of Tzoumakers emerged, integrating key components of two prospective proposals. The chronology of the deliberation process, the proposals and the outcomes are openly available online.

Fig. 1: Biomaterials workshop with researchers from the "Materiom" initiative.

Fig. 2: Snapshot from the public deliberation on the future of Tzoumakers.

Paving an alternative technological pathway

Various factors, encompassing both local and global challenges, motivated the creation of Tzoumakers to support local smallholder farmers. Namely, mainstream agricultural technologies available on the market are primarily designed for large-scale agribusiness and are, therefore, unsuitable for small-scale, mountainous, and organic farming (Giotitsas, 2019; Pantazis & Meyer, 2020). Additionally, local farmers encounter several obstacles in adopting new digital technologies, such as precision technologies, despite the fact that digitising production is touted as crucial for sustainable agriculture (Abdul-Majid et al., 2024; FAO, 2022; FAO & IPA, 2023). These obstacles include inadequate infrastructure, digital illiteracy, and insufficient funding, which prevent local farmers from reaping the benefits of digitisation (Trendov et al., 2019; Pantazis & Meyer, 2020). However, even those farmers who are able to adopt new technologies may face patent restrictions on modifying, repairing, and maintaining their equipment (Giotitsas, 2019). These farmers may also have limited control over the data they generate, which can be exploited for private profit without their full consent (Fraser, 2019).

Furthermore, as explained in section 2.1, strategies for technology adoption overlook the externalities associated with the entire life cycle of technology and ignore local specificities and the influence of powerful corporate

interests. Moreover, the current growth and innovation-oriented trajectory disregards farmers 'inherited tacit knowledge about natural systems and appropriate tools/techniques for their locality and needs (Giotitsas, 2019). Due to their geographical and technological isolation, local farmers 'problems, viewpoints, and accumulated expertise are often ignored. As a result, farmers remain marginalised from sustainability discussions and have little option but to comply with unsuitable technologies and approaches.

To counteract these challenges, a core objective of Tzoumakers is to empower the technological autonomy of local farmers. Technological autonomy emphasises access to appropriate equipment, infrastructure, knowledge, and skills. It also requires a critical understanding of the broader context that shapes agricultural technology and relevant policies, in order to participate in and contribute to crucial discussions and decisions.

To achieve their objectives, Tzoumakers follow the configuration of cosmolocal production. Cosmolocal production has a simultaneously local and global orientation and is based on the commons 'philosophy and values of reciprocity and self-organisation (Ramos, 2017). Technology development within a cosmolocal context prioritises socio-ecological well-being over corporate profit, emphasising local sovereignty, cultural diversity, and the global common benefit (Schismenos et al., 2020). Furthermore, it aims for conviviality as a counterpoint to industrialism, highlighting the significance of social autonomy in the construction of technology (Kostakis & Tsiouris, 2024).

Fig. 3: Snapshots from the manufacturing process of a grinder for aromatic plants, utilising locally sourced scraps.

Firstly, the cosmolocal configuration combines local hardware manufacturing with global knowledge exchange (Ramos, 2017). Manufacturing occurs within a physical space, a makerspace, where community members can access manufacturing equipment such as 3D printers, CNC machines, and essential low-tech tools. Concurrently, the community can access resources (e.g., designs, bills of materials, manuals) available online as digital commons and use them to develop these artefacts and contribute their own solutions and adaptations. These digital commons are distributed under appropriate licences (e.g., Creative Commons) for downloading, using, modifying, monitoring, and improving. Secondly, the cosmolocal approach focuses on creatively adapting open-source technological solutions to local contexts. Adaptation considers specific biophysical conditions and aligns with value systems defined by the participants (Kostakis et al., 2018). Rather than promoting unilateral technological visions, the emphasis is on enriching the global digital commons with diverse solutions and good practices. Thirdly, the cosmolocal approach adopts the concept of "mid-tech" to achieve a balanced synthesis of high-tech and low-tech (Kostakis & Tsiouris, 2024). The mid-tech approach blends high-tech efficiency with the autonomy and resilience of low-tech alternatives, drawing on the benefits of both extremes (Kostakis et al., 2023b).

Cosmolocal production presents numerous environmental and social advantages. For example, it favours the use of locally available materials, reducing reliance on global supply chains, cutting transportation, and bolstering local and circular economies (Kostakis, 2019; Priavolou et al., 2022). Additionally, sharing infrastructure, using recycled materials, designing for durability, repair, and reuse rather than planned obsolescence, and tailoring production to

meet demand and necessity decrease costs and environmental impacts and support economies of scope over scale (Kostakis et al., 2018; 2023a). Communities benefit from or contribute to a global collaborative network with adaptable solutions (Kostakis et al., 2018). Each community member can share and enhance their knowledge and skills, inclusively considered in decision-making, design, and manufacturing processes. Moreover, the cosmolocal approach nurtures grassroots innovation and bridges the gap between traditional wisdom and high-tech, harnessing farmers 'expertise (Giotitsas, 2019).

Despite the benefits of cosmolocal production, several difficulties and contradictions remain unresolved. For instance, the licensing and standardisation of open-hardware solutions is challenging and requires further institutional support and coordination among an international research and practice community (Costanza-Chock, 2020; Kostakis, 2019). Furthermore, cosmolocal production relies on energy and material-intensive infrastructures such as the Internet, contradicting the effort to alleviate pressure on natural resources and local populations (Kostakis et al. 2018). Moreover, as relevant studies from other makerspace environments show, there is a general ambiguity about how each community interprets sustainability and integrates it into their production methods and technology development (Berglund & Kohtala, 2020; Kostakis et al., 2018). Nonetheless, Tzoumakers, like similar initiatives, constitute a field of transdisciplinary observation and ongoing experimentation (Berglund & Kohtala, 2020) that is helpful in appropriating technology at the grassroots level and critically approaching sustainability in the context of technology.

The Potential of Commons-Based Technological Futures

Informed by a grounded perspective anchored in the daily challenges of their locality, Tzoumakers begin with the acknowledgement that the current situation is unsustainable both locally and globally in the short and long term. As in many places across the country and around the world, factors such as the centralisation of governance, enclosure of the commons, and post-war modernisation have led to significant demographic shifts, a decline in the rural economy, and overarching changes in ways of living and societal norms. All this erodes community cohesion and disturbs ecological balance. The substitution of vernacular wisdom with expert knowledge, the imposition of alien technologies, and inadequate governmental policies further exacerbate these issues. The global multi-crisis is compounding these challenges, leaving these communities ill-equipped to confront them.

Looking straight into the troubled, inescapable present (Zaliwska & Boler, 2019), however, serves for Tzoumakers as a motive for action rather than a reason to passively accept prevailing narratives that no alternatives exist (or may exist). In this direction, Tzoumakers exemplify how society-led technology development can leverage the construction of different pathways premised on the organisation and ontology of the commons.

As a commons-based institution, Tzoumakers embody the core values of sustainability, equity, reciprocity, and justice in their operational ethos. Their organisation showcases inclusive decision-making processes and cooperative technology development, illustrating the potential of scaling wide by forming regional and global networks and partnerships with regular institutions. This approach illustrates how commons-based institutions may increase opportunities for adaptation and learning in an uncertain, changing world (Ostrom, 2009) through collaboration and open knowledge exchange. This attribute is also consistent with and complementary to the local community's legacy of adaptive ingenuity in dealing with complex environmental conditions and keeping pace with changing circumstances despite isolation from infrastructure and decision-making centres.

Drawing on their community's resilience in the face of adversity and neglect, the Tzoumakers 'approach to technology development shifts attention away from the artificial dilemmas perpetuated by techno-optimist assumptions (high-tech versus low-tech, optimism versus pessimism, hope versus despair). Instead, they pivot from the rhetoric of high-tech as a panacea towards a deeper interrogation of technology and the ethical questions that precede it. Departing from the notion of a one-size-fits-all technology for growth-driven sustainability, Tzoumakers emphasise technological diversity, akin to biological and cultural diversity, as crucial for veering away from the current destructive trajectory (Hui, 2023). Technodiversity unfolds naturally within the cosmolocal context, fostering tailored solutions through inclusive practices, considering local specificities (natural, cultural, social), traditional wisdom, and the creative integration of high- and low-technology (mid-tech).

As a result, Tzoumakers 'work reflects pivotal characteristics echoed in the interdisciplinary discourse on forging

alternative technological trajectories. This discourse prioritises conviviality and diversity and points towards the democratisation of technology and "pluriversal" futures. Namely, futures premised on more inclusive, diverse, non-Western perspectives on life, humanity and nature (Escobar et al., in press; Lawhon et al., 2023; Velasco-Herrejón et al., 2022). Within this discourse, approaches to technology from different fields and cultures meet under the umbrella of Critical Futures Studies, where attention is drawn to worldviews, values and ontologies that have been systematically ignored or suppressed by the dominant techno-scientific regime (Feukeu, 2024; Goode & Godhe, 2017; Ramos, 2003). Further, as highlighted by Kostakis et al. (2023a), Tzoumakers actively contribute to improving and consolidating a convivial technological framework epitomised by cosmolocalism. Such a framework delves into the deeper complexities of technology (i.e. socio-environmental externalities, political and ontological aspects) and is essential for envisioning a post-growth society (Kostakis et al., 2023a).

Centring their efforts around technology while having a broader vision for sustainable futures, positions the initiative within a distinct category of social movements coined by Hess (2005) as technology- and product-oriented. These movements do not merely oppose the status quo by critiquing the shortcomings and questionable motives of top-down strategies, nor merely promote existing alternatives (Giotitsas, 2019). Instead, they take a step further by engaging in collective action to raise awareness of the current situation and produce technological alternatives (Giotitsas, 2019). In doing so, these movements can develop new design practices and bodies of knowledge that are not at the service of the industry, but are capable of transforming it (Hui, 2020), while looking towards more profound systemic changes.

The outcome of these endeavours is uncertain. As Feenberg (1999) suggests, the emancipatory potential of such grassroots movements could be perceived as simply reinforcing existing technological norms. Their work may impact current technical rationality, but their political objectives could be assimilated into existing structures without catalysing fundamental shifts (Feenberg, 1999; Giotitsas, 2019). Nevertheless, Tzoumakers, like similar initiatives, choose to confront future uncertainty by approaching the present situation as if it were "in a state of pregnancy" (Fromm, 1968/2010), refusing to passively accept the established trajectory. For Tzoumakers, uncertainty again seems to be a motive for action rather than a force of stagnation and blind acceptance of fraudulent hopes. Hope in the context of Tzoumakers relates to embracing this uncertainty while extending beyond mere optimism or hopelessness. Their motivation to act despite uncertain outcomes is bolstered by the confidence gained from a grounded, collaborative, step-by-step process.

Crucially, navigating uncertainty relies on trusting relationships, mutual support, and emotional exchange. The commons-based organisation and values offer the community opportunities, space and resources to discuss, share feelings and ideas, adapt, and innovate on their own terms and ethical considerations. As discussions about the future of Tzoumakers have revealed, a significant outcome of the initiative's efforts has been the creation of social bonds, collaborations and friendships. These relationships are founded on principles of openness, solidarity, ecology, the democratisation of technology, and a common vision of shaping a desired future within the present "we" seek to transcend.

In light of these, considering the case of Tzoumakers as a commons-based institutions that may inspire the emergence of collective hope and action, allows for the intersection of the technology-related discourse with the emerging field of Possibilities Studies (Escobar, 2023; Glăveanu, 2023; Ross, 2023). That is because these institutions, as Braithwaite (2004) explains, provide a safe space for people to imagine and pursuit desired futures, free from the blindfolds of authority (Fromm, 1968/2010) and the monocle of Western modernity.

Ultimately, the multidimensional activity of Tzoumakers expands widely on various scales and discourses on technological futures. This way, scholars from different fields, practitioners, citizens, and other stakeholders can engage in a transdisciplinary dialogue about technology and its fundamental role in sustainability. Such an exchange aims to debunk and move beyond empty techno-optimist promises. These promises denote false hopes for salvation, progress, development and power promoted by Western, capitalist, or other hegemonic forces, as documented in different geo-historical contexts (e.g., in cases of State socialist regimes) (Barca, 2020). The point of commons-based initiatives like Tzoumakers is to recuperate and build consciousness and sovereignty of technology from the grassroots. That is to empower people discern fraudulent hopes from actual possibilities, be able to estimate the impact of our actions (or inaction), and dare imagine alternative trajectories and engage in shaping them. The potential of making-with, thinking-with and coping-with that is put forward (Zaliwska & Boler, 2019) by the

commons-based institutions is vital for dealing with the present trouble and critically envisioning, hoping and acting together for a better, yet undetermined and unpredictable future.

Conclusions

Techno-optimism, dogmatically promoting universal high-tech futures as the sole path forward, dominates mainstream sustainability discussions. However, such a myopic perspective neglects the broader implications of technology and its symbiotic ties to the capitalist-consumer economy. This narrow perspective pushed by dominant institutions to serve vested interests may be seen as a hegemonic form of public hope that stifles critical discourse and leads to social stagnation. The article argues for alternative technological pathways, highlighting the potential of developing technology based on the commons. In this direction, I use the illustrative case of Tzoumakers, a grassroots initiative based in rural Greece. Research on Tzoumakers has shown how the commons-based approach, exemplified by "cosmolocalism", can provide an alternative framework for technology production and challenge the current trajectory fostering local and global collective action.

The paper advocates for commons-based institutions as sources of collective hope, although this conceptualisation requires further exploration. In this regard, stepping beyond the boundaries of this paper, future research can delve into how Tzoumakers 'collective action mirrors the context of hope connecting with broader studies on the topic (e.g., Haro, 2010) and with other communities of practice. A more comprehensive exploration of the role of hope could deepen our understanding of the political and social potential of hope within commons-based initiatives, encouraging interdisciplinary dialogue and the emergence of good practices towards society-led transformative changes.

Ultimately, commons-based institutions foster the flourishing of trusting relationships and cultivating collective ingenuity through knowledge exchange and experimentation. These institutions provide a platform for people to address present anxiety and future uncertainty. In essence, communities around commons-based institutions share a vision and the responsibility of cooperating for sustainable pluriversal futures for technology and beyond, entailing numerous potentialities waiting to take shape.

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Publication III

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A tunnel to the other side of the world: what sort of writing can contribute to social change?

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ABSTRACT

Journal articles are not widely read, so can academics cultivate their skills in genres which are more popular and persuasive? Can we 'write differently'? This paper presents an account of a children's story aimed at engaging children and adults in understanding the relationship between inequality and the climate and ecological crises, and aimed at stimulating readers to engage in social change. The subtext of the children's story is a critique of mainstream political economy through using the concept of 'cosmolocal' production relying on ideas about the commons. We explore whether and how academics can convey these ideas effectively through different forms of publication, and we focus on comparing children's books and journal articles. Many academics would agree that they want to co-create a better future by addressing wealth inequality and environmental degradation through alternative economic and technological models. The question is whether journal articles help achieve that aim.

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'Truth is a matter of the imagination.'

— Ursula Le Guin, *The Left Hand of Darkness*, 1969

'But the child never took to fairytales …

Enough now! We have to tell the children the truth.'

— Manolis Anagnostakis, *Ο Στόχος*, 1970

Introduction

The world is changing around us. Wealth inequality is increasing while humans and non-humans are facing an existential crisis. Many commentators and politicians appear to place their bets on technology that is yet to come to address the climate and ecological crises. For example, in their book *Why Can't We All Just Get Along? How Science Can Enable A More Cooperative Future* (2018), MIT scientists Christopher Fry and Henry Lieberman investigate the causes of wars, wealth inequality and other social problems. Their argument revolves around the prevalence of a competitive mindset within our institutions and businesses, which they claim hinders effective cooperation in solving these major issues. However, they provide a glimmer of hope by highlighting the potential of modern technology in tackling the root cause. They assert that competition arises from scarcity, and recent technological advancements, like 3D printing and artificial intelligence (AI), can eliminate

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widespread scarcity (see also Bastani 2020). Consequently, they envision a future where cooperation takes precedence in a post-scarcity world.

Engineering an account of the future in which high technology solves all our problems is fairly easy. It fits well with the dominant stories being told by corporations, governments and universities, all heavily invested in suggesting that the present age can continue. This world is mostly imagined in techno-capitalist terms because that's where the big money is, whether in research grants, intellectual property or profits. 'Catapults' accelerate 'innovation'; 'partnerships' and 'collaborations' focus on 'translational' research. Tragically, though, the hyperbolic language used to describe both means and ends effectively disguises that this is a continuation of the same forms of technology and organisation that got us into this mess in the first place. In this paper, we argue that we need futures that are not yoked to this narrow understanding of technology and instead in which different forms of social organisation help to produce a possible future on an increasingly lively planet (Parker 2024).

Many dominant stories promoting technology-mediated futures find their audiences through orthodox academic journals, the business press and the public relations of big tech companies. So, how can other accounts find an audience? Such alternative stories play a twofold role. First, they aim to better represent our current predicament, exposing uncomfortable truths often neglected in discussions about green growth and technological innovation (Weder et al. 2021). Second, they take up the challenge of communicating the urgency for radical change and possible pathways forward to wider audiences, not only those already convinced (Voci and Karmasin 2024). This paper presents such an attempt to write differently, for different audiences, and not just communicate with other academics.

Embracing our multiple identities as academics, authors, artists, activists, and parents, we created a picturebook accessible to very young children to communicate an aspect of current social and environmental injustices. The book was part of a project which explored how to communicate post-capitalist ideas to wider publics and was supported by the P2P Lab, a collective of researchers and activists studying the intersection of open-source technologies, post-capitalism and the commons.[1] The P2P Lab has been attempting to communicate their ideas and findings beyond academia, to people of all ages from all over the world. They have experimented with different communication formats, such as short form video, but this paper presents the picturebook, an outcome of this experimentation, and discusses various aspects of its content, context and objectives.

We initially considered this book part of a necessary attempt to talk openly to children about the predicament their generation is destined to face and hint at a possible way out—a strategy that is premised on intergenerational solidarity. While children may lack a direct voice in shaping our present actions, adults have a responsibility to ensure that their interests are safeguarded (Benevento 2023). Our choices today will reverberate through their lives, defining the world they inherit and the possibilities they encounter. How, then, can we convey the complexities of our current reality to a younger generation? How can we engage them in a dialogue that sparks their imaginations, instils a sense of agency, and empowers them to participate in co-creating a more inclusive and sustainable tomorrow?

The book also aims to catch the attention of 'all those grownups who, as children, died in the arms of compulsory education' (Cullum 1971, n.p.) and have since become prone to the various forms of common sense and complacency of the adult world. The story in the book is straightforward, but messages are hidden within the text and pictures, waiting to be discovered, trigger questions, and motivate further exploration of future possibilities. Hence, we consider the book a crossover, or cross-writing, an attempt at targeting dual audiences (Beckett 1999; 2012; Knoepflmacher and Myers 1997).

Taking this cross-writing approach, intuitively and intentionally, was probably inevitable. That is because picturebooks for very young children 'are designed to be read by adults to children, and thus, by adults *and* children' (Bullen and Nichols 2011, 214). Also, 'the first audience for any book

that might be published is not children at all, but rather the adults who edit, publish, teach, and review the books' (Enciso et al. 2010, 253). Adults must be attracted, persuaded and convinced for the books to be published, marketed and bought (Stan 2000; Wall 1991).

Our effort to reach the desired readership, however, stumbled upon some predictable obstacles, prompting us to consider the difficulties of telling stories about a topic that doesn't sit well with dominant stories and traverses disciplines and genres. It seems to us that the experience of trying to publish the book has some lessons for academics who want their writing to contribute to social change but usually restrict themselves to communicating through academic journals. In presenting our attempt to communicate complex concepts differently, we must also necessarily discuss the obstacles that emerge from the relations between knowledge, publishing, and markets and which operate as filters that determine what is to be heard and what is not.

We first introduce our story, 'A tunnel to the other side of the world', accompanied by four draft illustrations courtesy of the artist Tonia Vita. Then, we reflect on the various layers of meaning (and feeling) derived from this children's tale that touches upon ecological crisis, inequality, and post-capitalist social change. As an example, we introduce a form of socio-economic configuration premised on the commons and a local-global collaboration—'cosmolocalism'.

Commons-based forms of organising are pivotal in post-capitalist discourses and play a crucial role in exploring post-growth organisations and alternative pathways for technology (Pansera and Fressoli 2021). While the commons has been neglected in management and organisation studies, the concept is gradually attracting growing interest (Fournier 2013; Munro 2023; Murillo, Guinart, and Arenas 2024). The example of cosmolocalism is by no means the only way to think about what it will take to produce an alternative economy, but it allowed us to frame some of the ideas in our children's book.

The core question for this paper is how best to communicate the need for radical social change. To put it bluntly, is it better to write a children's book or a journal article? Which is more likely to result in changing beliefs and actions? The paper concludes by asserting the importance of hope and the possibility of alternative pathways, the light at the end of the tunnel, and how to show it to other people.

The story: a tunnel to the other side of the world

Zoe wants to play with her dad's phone. But her dad won't let her. 'I'm busy,' he says. 'Go do some digging. Go and find some treasure. Put it in your bag and bring it back to me.' He gives her a bucket and a spade and starts talking on his phone again (Figure 1).

Zoe digs while her dad talks on his phone. You can find many treasures by digging! Here is a worm that likes to live in the soil. Here is some rusty metal. Here is an old piece of pottery (Figure 2).

Deeper still. Here are the roots of a big tree! 'I will not hurt them because the tree drinks water and eats its food through its roots' thinks Zoe. She carries on digging. Her dad is still on the phone.

She gets to a part of the earth with big rocks that she has to dig out of the way, then finds two beautiful red stones. 'I will carry them in my bag and start building a little red house with them'.

What a huge tunnel Zoe has made while her dad is still on the phone! 'I will find what is hidden at the other end of the hole.' she says to him. But he is not listening.

She keeps digging, and digging, and digging. Then, suddenly, she sees light.

Her head pops out in a strange place on the other side of the world. The sun is burning hot, and the air smells dusty, but look how many children are digging! And here, the parents dig too (Figure 3).

Zoe walks up to the child and asks: 'What kind of treasures are you looking for?'

'Copper and cobalt' the child answers. 'What games do you play with them?' Zoe asks. 'We do not play games', he says sadly. 'We sell them to the grown-ups on the other side of the world.'

'What do grown-ups do with your copper and cobalt?', Zoe asks. 'They make phones' the child answers and goes back to his digging. The child has no time for games. He must dig in the sun so that grown-ups can talk on the phone.

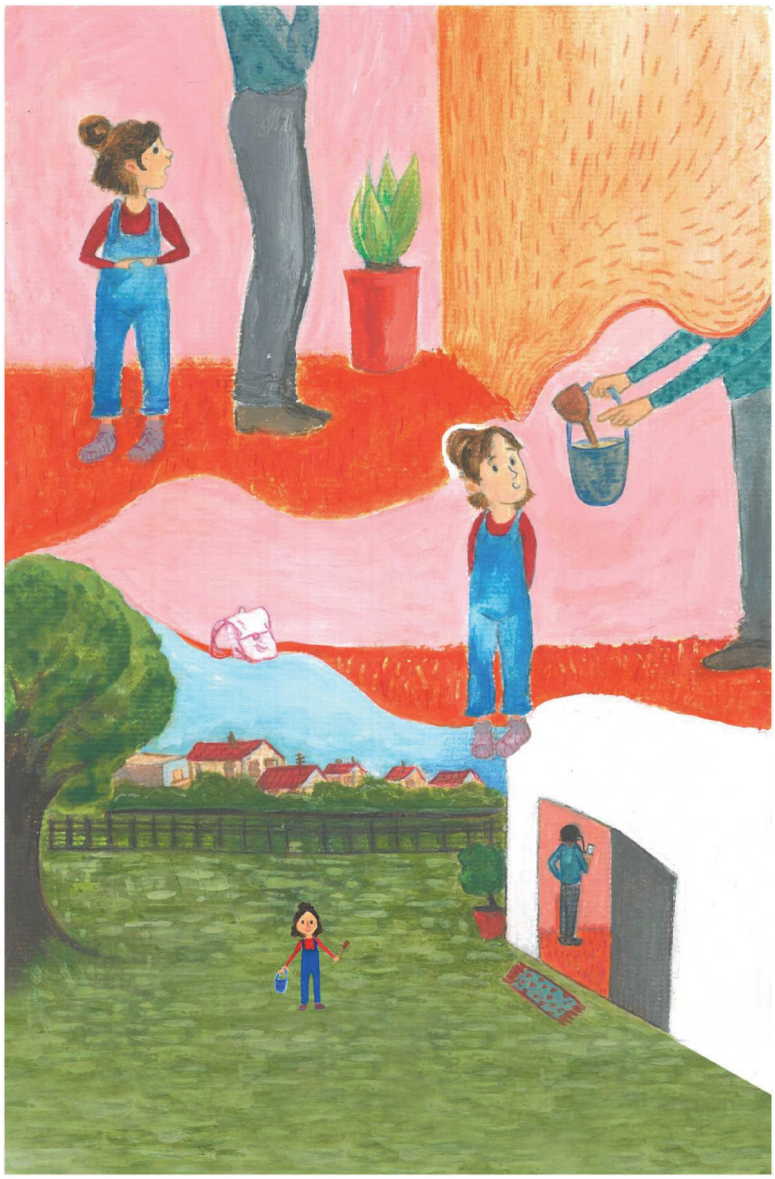

Figure 1. Zoe and her father. Draft drawing, courtesy of Tonia Vita.

'This isn't fair' Zoe thinks 'not fair at all!'. 'What is your name?' she asks the child. 'Beno', he says.

Beno and Zoe sit together and laugh. Zoe shows him the red stones from her bag, and they come up with a great idea! He will stop looking for copper and cobalt and instead look for coloured stones too. They will share them through the tunnel (Figure 4).

They can share shovels and buckets too, and ideas. And then they will build wonderful houses with their friends at both ends of the tunnel.

Zoe says goodbye to Beno, promising to see him the next day. Then she goes back through the tunnel, to tell her dad what she has discovered.

Zoe pops her head out of the tunnel and sees that her dad isn't on the phone anymore. 'Where have you been Zoe?' he says, in a worried voice.

Figure 2. Zoe is digging. Draft drawing, courtesy of Tonia Vita.

Zoe tells him about Beno, and her dad looks thoughtful. 'After dinner, let's go through the tunnel and talk to Beno about building wonderful red houses,' he says. And they do. And, for the rest of the day, her dad didn't use his phone at all.

Genres and audiences

We wanted our book to be a crossover picturebook, simultaneously addressing children and adults (Beckett 2012). Pictureboooks have traditionally been considered a children's genre, though contemporary illustrators and graphic novelists indeed challenge such assumptions. Picturebooks differ from illustrated books in that the pictures not only support the text but comprise an additional narrative such that the visual and textual narratives are intertwined and mutually interanimated (Lewis 2001). In the case of our book, some pictures enrich the text visually; for example, when Zoe meets Beno (Figure 3). Other pictures add layers of meaning, inviting further contemplation and

Figure 3. Zoe meets Beno. Draft drawing, courtesy of Tonia Vita.

opportunities for emotional engagement and conversation between the child and the adult. For example, in the image where Zoe talks with her father (Figure 1), he appears headless, disengaged. The interplay between textual and visual narratives can offer a reading experience in which preliterate children read the pictures while the adult reads them the words. Beckett (1999, 2012) argues that picturebooks provide a unique opportunity for a collaborative, shared, and intergenerational reading experience, equally empowering children and adults more than any other narrative format.

This plural nature of picturebooks (Lewis 1990) encouraged us to incorporate aspects of our academic research within a fictional story to make it accessible to children and adults. Unlike narrower and drier scientific and knowledge-based approaches, we wanted to use a relatable and engaging communication medium (Benevento 2023; Cutter-Mackenzie and Rousell 2019). Our aim was to produce impactful writing about pressing challenges to encourage consideration of alternatives and motivate transformational action (Lindgren Leavenworth and Manni 2021; Wals and Corcoran 2012).

Addressing children, communicating the climate crisis, or the violence depriving Beno of his childhood requires a sense of responsibility and care (Cadden 2000). Although such topics may evoke negative emotions like fear, anxiety, and desperation, it seems to us and others that distressing ideas should not be bypassed but rather treated in a way that works for a child audience (Cadden 2000). Hence, instead of trying to 'protect' children (or ourselves) from the facts, our story explores the truth through Zoe's adventure and sheds light on Beno's heartbreaking reality.

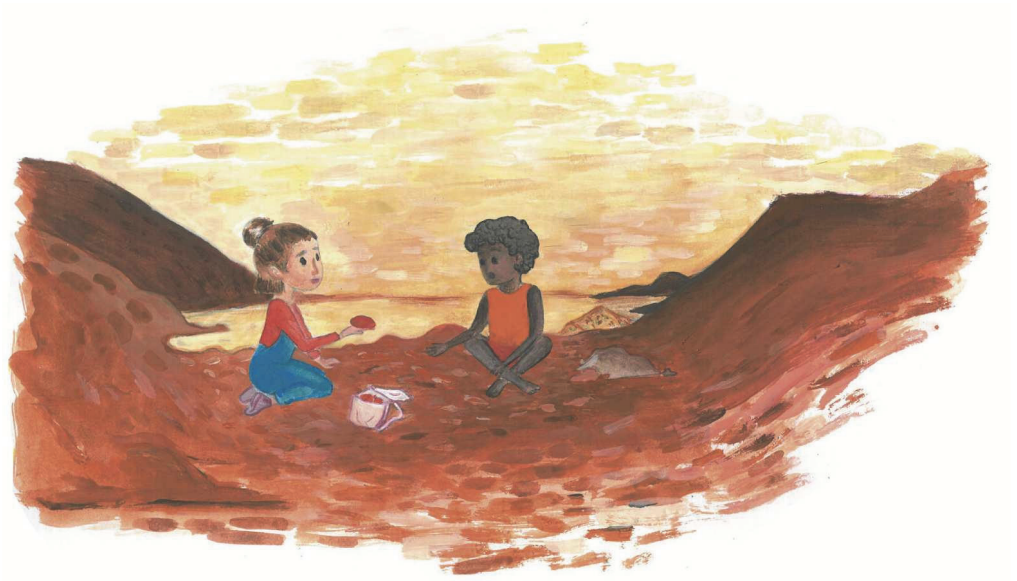

Figure 4. Zoe and Beno are setting up a plan. Draft drawing, courtesy of Tonia Vita.

The flexibility of crossover picturebooks also facilitated our experimentation with reaching out to wider academic and non-academic audiences. The creative process of making the book has been a hands-on experience of 'writing differently' (Grey and Sinclair 2006; Pullen, Helin, and Harding 2020), even to the extent of writing this academic article about it. This allowed us to temporarily escape from the 'aesthetically flawed […] dry, obscure, and clunky' academic writing that marginalises other ways of being and knowing, reproducing certain Western, masculine, authorial scientific norms (Weatherall 2023, 515). Academic language is defined by long sentences, embedded sub-clauses and dense vocabulary, so we wished to experiment with what it might mean to write in simpler and more direct ways and not to neglect embodied experience in favour of abstraction and cognition (O'Shea 2019; Pullen, Helin, and Harding 2020). This means that we were forced to reconsider how we relate to our audiences, and to try and extend our readership beyond small self-selecting groups of scholars (Gatto 2023).

Through the story of Beno and Zoe, we tried to communicate some complex issues in a simple way, to write differently. The following section provides an academic account of the assumptions behind the story in the book.

Behind the story

Whenever we share the story of Zoe and Beno with kids, they bombard us with questions that seem obvious to them. Why must Beno gather minerals and not play with his friends? Why are grown-ups so obsessed with their phones (and work) instead of spending time with their children? Why don't Zoe's parents work with Beno's parents to solve their problems? And why don't they share resources when there are enough for everybody? Responding to these 'why' questions is complex, challenging the skills of a parent, an educator, a carer, or an academic who wants their work to have some sort of social impact.

Allegedly, mainstream economists can provide answers to all of these questions and supporting them are sophisticated mathematical models. Mainstream economics 'proves' that the present world is on track to raise living standards for all if markets are allowed to do their work (Reinert 2008). According to the dominant rationale, Beno and his compatriots in the Global South should continue

extracting minerals for mutual global benefit. That is because abundant mineral resources and cheap labour in 'developing' countries are their comparative advantage. In this way, the role and future of children like Beno are predestined. Likewise, policymakers and politicians from the Global North 'prove' that it is in everyone's interest if the 'developed' countries have a comparative advantage in design. Hence, it makes sense that the rest of the world should deliver the raw materials necessary to materialise these designs. However, despite this logic, the wealth gap continues to grow, the democratic deficit persists, and climate and ecological catastrophes are looming.

Popular narratives such as 'green growth' (Perez 2019), 'ecomodernism' (Asafu-Adjaye et al. 2022), or 'accelerationism' (Williams and Srnicek 2013) place our hopes for addressing these problems on new technologies. 'Smart' and 'seamless' digital tools will optimise the effectiveness and efficiency of services, reduce resource consumption and CO2 emissions, increase productivity, and engage citizens more actively. Yet, these perspectives fail to recognise that technology extends beyond the physical artefact to encompass its entire lifecycle—spanning design, manufacturing, use, maintenance, and disposal—as well as the ownership and control of the knowledge surrounding it (Giotitsas 2019; MacKenzie and Wajcman 1985). More critically, all technologies are embedded with social interests, values, and human-nature relationships (Feenberg 2002). Consequently, technological solutions alone cannot fully address all problems, particularly when disregarding this broader and intertwined complexity.

So how does all this relate to our children's picturebook? The story unfolds around a mobile phone. We get introduced to Zoe when she asks her dad for his phone to play. But he urges her to play outside. He is about to make a call. Later on, Zoe discovers Beno's world. That is where the raw materials needed to manufacture smartphones, like her dad's, are extracted. Beno explains to Zoe why he is not playing like her instead of working, and what kinds of 'treasures' he is forced to unearth. Using the smartphone as a reference helped us signal two of the major problems of our times: environmental degradation and wealth inequality. The concentration of the production of these high-tech artefacts within the capitalist context significantly contributes to these problems.

Smartphones, and other high-tech artefacts (e.g. sensors, solar panels, EVs), require scarce metals and rare minerals. Such resources are often extracted under exploitative labour and environmental conditions in the Global South (Sovacool 2019). The Democratic Republic of the Congo, perhaps Beno's homeland, is one of the world's most richly endowed countries in terms of mineral wealth. Within the narrative of comparative advantage, delivering copper, cobalt, tin, tantalum and lithium to industrialised countries is their opportunity within the global economy. Yet to produce, use, and recycle high-tech artefacts, energy is consumed, toxins are generated, and inhuman and precarious labour is frequently involved (Lange, Pohl, and Santarius 2020; Sovacool et al. 2020). As with the resource transfers (mineral, vegetable and human) that took place during the hundreds of years of European imperialism, it seems that digital capitalism is similarly predicated on mining in the Global South to manufacture technologies that will be used primarily in the Global North. The purchase of a finished product effaces how these artefacts were designed, manufactured, and transported (often from one side of the world to the other) or how these artefacts will be disposed of (Hornborg 2016). 'Our' technologies often exist at the expense of other humans and ecosystems elsewhere in the globe (Fuchs and Horak 2008).

Even 'efficiency improvements' often lead to an absolute increase in consumption due to lower prices per unit and a subsequent rise in demand. For example, the invention of more efficient steam engines allowed for cheaper transportation, which catalysed the Industrial Revolution. This did not reduce the rate of fossil fuel use but increased it (Alcott 2005). When more efficient machines use less energy to produce and consume, they cost less, and thus, people tend to use them more.

One of the lessons of capitalism is that people tend to consume more when they can (Hickel and Kallis 2020; Kallis et al. 2018). The economic and political demand to grow the Gross Domestic Product values such behaviour because the bigger the economy, the better it is. But GDP is a particular metric that values certain behaviours, such as spending, and ignores others, such as self-provisioning, sharing, non-monetary exchange, volunteering, and so on. Calculations about the

'efficiency' of technology rely on ignoring wider senses of value. Would these technologies look so attractive if one considered the true cost of Beno's labour and the destruction of Beno's local ecosystem needed to produce them in the first place? These are political choices involving antagonisms and unequal power relations (Hickel and Kallis 2020; Kallis et al. 2018), not inevitable outcomes of technological change.

The prevalent understanding of technology, as expressed by the green growth or ecomodernist narratives, is basically a reproduction of the same global social relations that have dominated since the beginnings of European imperialism. Modern technology is historically associated with various forms of colonial domination (Barca 2020; Paulson 2024). Since international business is still predicated on similar relations between Global North and Global South, we might assume that Zoe is destined to remain unaware of how her smartphone was produced, and Beno is left with no choice but to sacrifice his childhood.

Dominant forms of organisation and exchange shape our behaviour. How we produce, what we discuss and dream, how we raise and teach our children, and how we relate and fall in love, all seem to take place in the shadow of capitalism. Communicating alternative futures is imperative. An alternative pathway unfolds in the latter part of Zoe and Beno's story and is presented next.

Towards alternatives

Towards the end, our story provides a glimpse of hope. Beno and Zoe sit together and laugh. However, they do not ignore the injustices surrounding Beno's reality. Instead, they decide to act upon it. Their idea is simple: from now on, they shall begin to meet, share their tools, ideas, and emotions, and make something together. Upon her return, Zoe tells her father what she has discovered. Her dad takes a moment to digest her adventure and dedicates the rest of the day to his daughter.

Simple or not, their idea also hints at an alternative political economy. There are many terms and metaphors for a different economy—community economies, doughnut economics, the wellbeing economy, anarchism, the economy for the common good and so on (Parker et al. 2014). The one we hinted at in our picturebook was primarily based on ideas about the commons. The commons here is defined as social systems by which communities manage shared resources and produce goods cooperatively, prioritising socio-ecological well-being rather than profit maximisation (Bollier and Helfrich 2019; Ostrom 1990).

Zoe and Beno decide to create and maintain a commons. They agree to retain the 'tunnel' of communication connecting the two sides of the world. They will exchange some means of production (such as knowledge and inspiration) and build their imagined stone houses locally, on-demand, with the help of friends, sharing tools (shovels and buckets) and labour. They will self-organise and cooperate to achieve their goal. They do not think of transferring scarce resources from one side to the other. Zoe did not ask Beno to do the dirty work of extracting raw materials (in the Global South) while she designed shiny stone buildings (in the Global North). Nor did she ask Beno to build them for her. Their agreement challenges the assumptions of our present global trade system, proposing something else that seems fair and makes more sense to them.

Zoe's and Beno's future collaboration could be said to demonstrate an emerging configuration for production that one of us has elsewhere called 'cosmolocal' (Kostakis, Niaros, and Giotitsas 2023). Cosmolocal production integrates global knowledge exchange with localised manufacturing. Under the cosmolocal configuration, local communities are enabled to design artefacts (like smartphones or buildings) leveraging a global pool of knowledge resources (e.g. design files, skills, good practices, know-how) which is openly accessible through the Internet as digital commons (Kostakis, Niaros, and Giotitsas 2023). In turn, participants can enrich the digital commons with their own contributions. Within this commons, diverse ideologies and practices converge, forming what Gibson-Graham (2002, 52) refers to as 'communities of difference.' Physical production occurs locally in shared infrastructures, like makerspaces and fab labs, employing cooperative practices,

and is ideally aligned with participant-defined value systems and local biophysical conditions (Kostakis, Niaros, and Giotitsas 2023). The simultaneous local-global orientation of cosmolocal production empowers local autonomy, sufficiency and diversity while fostering a sense of global common benefit (Schismenos, Niaros, and Lemos 2020).

A primary goal of cosmolocal production is to reduce material and energy footprints by minimising the negative impact on other ecosystems (Kostakis et al. 2018; Manzini 2015). It also seeks to reduce dependence on global value chains and standardised, market-available technologies. Instead, cosmolocal production promotes designing durable, repairable, affordable and context-appropriate technologies tailored (or adaptable) to regional needs, capacities, available resources, and cultural specificities (Kostakis and Tsiouris 2024; Priavolou et al. 2022). Zoe and her friends may build houses with red stones, while Beno and his friends, on the other side of the tunnel, may build different houses with yellow stones. It's up to them to decide, considering their needs and local context.

There are many initiatives, mainly from the Global North, which exemplify cosmolocal production, such as L'Atelier Paysan (agricultural machinery), RepRap (3D printers), WindEmpowerment (renewables), WikiHouse (buildings), LibreSpace (nano-satellites), and OpenBionics (robotic and bionic devices). Cosmolocal initiatives foster ecosystems of small-scale, locally-oriented communities while building global collaborative networks. These networks facilitate the expansion of cosmolocal projects by disseminating and exchanging knowledge, solutions, ideas, and experience (Kostakis, Lemos, and Kouvara 2024). They also comprise the grounds for social action to address global challenges beyond temporary fixes and efficiency improvements collectively.

Unlike the corporate-driven approach of developing technologies first and finding applications (and markets) later, ignoring the urgency and complexity of today's challenges, cosmolocal initiatives go beyond simply producing technological solutions. Instead, they start with a broader vision for sustainable and equitable futures and demonstrate how society-driven production can contribute to reaching this aspiration (Kouvara 2024). Through the commons-based organisation, these initiatives enable hands-on involvement in crafting and manufacturing technologies while encouraging active participation in discussions and decision-making processes. This approach cultivates community awareness of current crises and broader challenges that extend beyond the local scale. Consequently, while delivering tangible outcomes to address specific local needs, often neglected by one-size-fits-all solutions, cosmolocal initiatives also engage in political advocacy on global issues, driving transformative change.

The adoption of a cosmolocal production paradigm holds the potential to create a more inclusive and sustainable global political economy premised on the core principles of the commons, like solidarity and care, ecological stability and cultural diversity, openness, reciprocity and trust, as we hope Zoe and Beno's story suggests. Cosmolocal production proposes alternatives to the dominant overproduction and excessive consumption patterns by enhancing local control, relying on human creative capabilities and cooperation to produce and maintain useful artefacts, and the sense of belonging through the creation of alliances via commoning. However, it is not without its tensions and contradictions. Several challenges remain unresolved, such as dependence on energy-intensive digital infrastructures, limitations in licensing and standardisation of open-source solutions, and limited institutional support for international collaboration (Costanza-Chock 2020; Kostakis 2019).

Nevertheless, it seems to us that a cosmolocal framework could potentially act as a catalyst for radical change, bridging diverse local initiatives to co-create a low carbon, high inclusion, high democracy economy, and ultimately practice an alternative paradigm. So, how can we communicate these ideas more widely?

Academic audiences

This paper has operated at what seem like two very different registers. First, we presented the backstory of creating a crossover picturebook intended to communicate some complex issues in simple

ways. Then, we provided an academic account of the assumptions within and behind the story, communicating some complex issues in complex ways. In this section, we want to think about the relation between these two registers and the modes of dissemination in each case.

So far, we have yet to find a publisher for our book. One major publisher from the USA wrote to us that our tale does not offer 'the inspiring, hands-on scientific focus' they are drawn to. This publisher seeks stories to inspire young people and perhaps considers that stories based on social science might not be inspirational. Our inability to get this book published may mean that we had not written a book that was understood by commissioning editors to have a market. It might also be that we hadn't approached the right publishers or approached them at the wrong time or in the wrong way. As with any form of cultural dissemination, there are explicit and implicit rules, and we are not experienced in them, having never written a children's book before or having an agent who is. Publishers are almost always commercial entities, and they require that the products they sell make them money to cover their costs and hopefully make a profit too. If they decided that our book would lose them money, they would be unlikely to agree to publish unless there was some subsidy or other commercial opportunity.

There are, of course, parallels here in terms of the inclusion of the text for a children's book in an academic paper for a journal. Academic journals have their own explicit and implicit rules too, and they are clearly rather different from those that apply to children's books. The spread of printing and literacy in Europe in the seventeenth century gave rise to a series of different forms of publication, each defined by who was the writer and who was the audience, how often it was published, as well as its physical characteristics and cost. The novel, pamphlet, chapbook, comic, newspaper, magazine and journal, were all attempts to sell words on paper to certain readers. This was true for 'academics' as well, with the first journals, *Journal des Sçavans in France* and the London based *Philosophical Transactions of the Royal Society*, both beginning in 1665.

The *Philosophical Transactions, Giving some Account of the present Undertakings, Studies, and Labours of the Ingenious in many considerable parts of the World,* was sold monthly at the price of one shilling. It was never much of a financial success at the time, but it did begin to construct the idea of a form of collective agreement about the importance of the provenance of ideas, their authorship and timing, as well as the beginnings of peer review. This latter element enabled the journal to present itself as a trusted serial publication because of the warrant provided by an editorial committee. *Transactions* borrowed the legitimacy of a social network of gentlemen in order to distinguish the reports of experiments, observations, or journeys published within its pages from fantastical claims made in other places, whether public houses or broadsheets (Csiszar 2018; Fyfe et al. 2022).

The gradual growth of the journal form from the eighteenth century onwards reflected the expansion of the professions—particularly medicine—as well as the development of learned societies, usually specialising in the natural sciences. Most were published by professional organisations and paid for by their subscriptions because it was rare that they found a more general market and could develop a wider audience such that they could sell alongside more commercial magazines in newsagents. Journals were almost always, with the exception of *Nature* and *Science*, small circulation, highly specialist, and largely unconcerned with growing a readership since their readers were already guaranteed by the profession or association.

By the late twentieth century, academic publishers had begun to develop their own journals or provide the organisational and digital infrastructure for academics to do so. The reason Taylor and Francis (T&F), who publish *Culture and Organization*, and lots of other academic publishers, can afford these very specialist and small circulation journals is because their income primarily comes from higher education library budgets (Harvie et al. 2012). T&F currently publish around 2700 journals[2], and are owned by Informa, an information corporation with a revenue of £3.2 billion in 2023.[3] In terms of journals, they are not really operating in the same sort of market as children's book publishers at all but are effectively acting as paid publishers, extracting value without needing to engage in marketing and distribution. In the same way that a firm might be employed to produce an 'in

house' magazine for a company, costs are covered, plus T&F's profits, and it doesn't matter whether anyone actually reads it.

Academic journals are published as a signal for universities and academics that a particular activity has been carried out, as well as a source of data that informs institutional rankings, appointments, promotions and so on. Many journals are not primarily concerned with cultivating readers. Indeed, it is often claimed that many journal articles are barely read (Prichard 2013), but this doesn't mean that publishing in them has been unsuccessful. When an article such as this one is published, the number of readers doesn't matter much, or even whether its ideas can be claimed to have any influence. The metadata will be scraped onto commercial websites, social media mentions will be counted and tabulated by geography and demography, and citations will be counted and fed into the databases that produce the impact factor of the journal, or one of the many other content and data aggregation platforms. The data will find its way into peer review metrics and automated university research management systems. It will also, of course, be inserted into a CV, submitted for annual reviews, job and grant applications. The article plays its function by being published, by communicating within the network of intermediaries, institutions and academics that valued activity is taking place. It's a sort of simulation of a market in writers and readers, in which publication isn't a consequence of an editor's assessment of an audience's enthusiasm, but of the extent to which a submission is agreed to be sufficiently similar to other submissions, to 'join a conversation', however muted and episodic. Once published, data about the publication is the signal that produces the information that matters (Parker 2023).

The contemporary academic journal is certainly a medium of communication, but not in the way that many people might imagine. If we set 'content' aside, then publication in *Culture and Organization* (for example) communicates activity within an academic disciplinary network, showing who is active and who is not, and information about that activity is then collected, tabulated and monetised by all of the actors within the network—academics, research administrators and managers, state policy makers, editors, publishing executives, professional associations, social media aggregators and so on. It doesn't matter much what is actually written, but where it has been published.

The irony of this comparison of children's books and academic journals is that we can only conclude that the children's book is likely to reach a wider and more diverse audience than an academic journal article. If it is read much, this article will be read by a small and specialist set of academics who work in universities and are likely to already be interested and knowledgeable concerning the sort of topics that *Culture and Organization* publishes on. This is the equivalent of preaching to the choir, that is to say, trying to persuade people who already agree with you. The readers of this piece are probably already interested in broadly left, green, feminist and socialist politics, and employed in the English speaking global university complex, probably in business schools, and hence on the right side of the paywalls which fund the journal. After all, most people don't even have access to the journal. So if we really want to communicate about social change, why don't we write a 'children's' book instead?

Writing and audiences

We could decide that academic journals don't matter, but that would be wrong. *Culture and Organization* and the thousands of other journals that T&F, SAGE, Wiley, Elsevier, Springer, Emerald, and others do serve a function for academics and their managers. However, if we imagine that they provide wider audiences, we are largely mistaken. Not only are they mostly publishing behind paywalls, but their dense vocabulary and sentence structure, references and endnotes, largely standardised design and absence of illustrations show that they are not concerned with cultivating audiences. They instead assume particular readers, defining academic sub-disciplines, concerns and styles in the journal statement, and using metaphors like 'joining the conversation', 'the literature' and 'the readership of this journal' to ensure that the boundaries of any particular journal readership are reinforced. As editors will often remind you, in order to get into the journal, as an author or reader, you have to already be able to write as if you were a member of the club.

Compare this to the children's picturebook, and in some sense, it represents the very opposite of the academic journal. It is a verbal text which is intended to be read as easily as possible with simple and attractive vocabulary and sentence structure; and a visual text which can even be read by pre-literate children, and complements the verbal narrative while offering additional layers of meaning. Both 'texts' are also usually self-contained, without making reference to any other text, and the design, font, illustrations, price, size, paper architecture and marketing will be optimised to ensure that as many copies as possible sell. These books are designed to find an audience, and their success depends almost entirely on whether they find readers. A children's story not read by children—and bought by parents and libraries—would have been a waste of paper and ink, a loss of money and a failure to communicate.

The question for us here is not necessarily whether academics should write children's stories *instead of* journal articles, but what other forms of dissemination might also be able to communicate the urgency and importance of ideas about social change. Between the children's book and the academic journal, there are many ways of thinking about how ideas might be introduced into culture, at least partly through the medium of text.[4] Consider teenage and adult fiction; popular trade books on science, business and economics; politics, economics and technology magazines of many kinds; comic books; YouTube and TikTok videos; plays; board games; open access educational websites; blogs; journalism, and so on.[5] Of course, academics are not necessarily skilled or trained in these other ways of thinking about how to communicate by text, but all these modes are available to them. Why, then, imagine that academics can only communicate through journals?

Some readers might respond by suggesting that this is their skill, their vocation, and hence that they should concentrate on being effective within university based teaching, research, and writing. That is a reasonable response, but it does mean that they are unlikely to see their ideas and concerns enter culture more widely, and hence any political aspirations they may have for their ideas are unlikely to be fulfilled. This is a particular problem for any journal, like this one, that mentions the word 'critical' in its 'aims and scope' statement. Being 'critical' implies some sort of commitment to working towards a state of affairs in which the criticism has been addressed, which suggests that widening the audience is a political imperative that should be backed up by a strategy. Not to do so would be hypocritical or, at the very least, politically naïve.

Without some sort of idea about how these ideas might find wider dissemination and become sustained practices which address the injustices identified, it is easy to see why many people who are not involved in the academic sign system would regard publishing in this journal as no more than a gesture, a virtue signal with no likely effects (Parker 2023). This impulse led us to write this children's story in the first place. We shared a sense that addressing a much wider field of cultural production was necessary so that our political concerns could find audiences.

With the book unpublished, it means that we have yet to achieve what we desired and are instead (ironically) writing another journal article. Nonetheless, we do not consider our time to have been wasted. Making the story and writing an article about it has been an opportunity to think and practice across genres in some unfamiliar and often personally challenging ways (Grafström and Jonsson 2019). Our collaborative creative process allowed us to explore how to communicate complex concepts—in this case, cosmolocalism and the commons—through two different genres. We have tried to think and practice 'writing differently' rather than merely writing about it (Pullen, Helin, and Harding 2020). We don't want to suggest that academics should not publish in academic journals or to suggest that *only* other ways (such as making crossover picturebooks and writing children's stories) are effective for finding audiences. Celebrating one approach as superior will unnecessarily limit the range of available tools that we have at our disposal.

Our main concern is to stimulate thought about what we can do with the tools and mediums closer to our skills, vocation and self-expression to raise awareness about alternatives such as cosmolocalism and the wide variety of proposals for an alternative economy. We are at a point where no more time is left to dedicate ourselves solely to critical debates and must instead engage in 'writing difference' into the world (O'Shea 2019) aimed at catalysing action. Weatherall (2023, 515) suggests

this could mean a deeper exploration of 'how a different, more inclusive, politics and ethics, could be developed and shared through academic writing' to provoke transformative change. We would like to think that our picturebook—aimed at children and adults, academics and laypeople—is just such a subversive text. We have disguised it as a children's book but intend it to convey some radical political provocations (Beckett 1999, xvi).

Conclusions

Some seek solace in the promise of future technologies to untangle our troubles, but we believe this disregards the potential dangers and unintended repercussions that technology may afford. Acknowledging that a sustainable and just world cannot be attained through technological advancements alone is imperative. Instead, we must explore alternative forms of social organisation and value creation, placing localisation, collaboration, sharing, and solidarity at the forefront. This paper presented such an alternative by discussing the concept of 'cosmolocalism' as a pertinent example of the evolving discourse on post-growth organisation, production and technology development.

To effectively convey the urgency of social change, we have considered questions of genre, style, and readership when communicating with different audiences. While valuable within academia, academic journals often remain inaccessible due to barriers like paywalls and complex language. In contrast, other more creative formats, like crossover picturebooks, can simultaneously be accessible to different readers, from very young children to adults, academics or not. This paper presented an example of such a book. Still, there are numerous other media of communication—such as fiction, trade books, magazines, plays, games, videos, and so on—which can serve as channels to reach wider audiences in the pursuit of meaningful transformation.

To effectively confront the challenges we face, it is insufficient to remain confined to writing in self-referential academic circles, speaking to each other through journals behind paywalls. For academics who care about their ideas contributing to social transformation, embracing alternative modes of communication is essential for connecting academia with society, encouraging different understandings and engagement with ideas about social and environmental problems which are currently marginalised by the dominant narratives. If we claim to be critical, then we need to learn how to write for audiences who don't yet agree with us. Zoe and Beno deserve no less.

Notes

1. See https://www.p2plab.gr
2. https://taylorandfrancis.com/journals/, accessed July 2023.
3. https://www.informa.com/investors/annual-report/, accessed May 2024
4. Which is to set aside, for the purposes of this paper, film, documentary, visual art, music, street art, dance, performance art and so on.
5. See, for example, the materials generated by The Other School, a project funded by the P2P Lab and Tallinn University of Technology. https://theotherschool.art/

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Another Scalability is Possible! From Nonscalability to Cosmolocal Scalability

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Abstract: This article addresses Anna Tsing's critique of capitalist scalability by introducing the concept of "cosmolocal scalability" as an alternative to approaches that prioritise "scale-at-all-costs." Cosmolocal scalability challenges the idea of homogeneous, frictionless expansion and instead proposes a context-responsive framework that values biodiversity, as well as the diverse ways of knowing and living. This framework enables local communities of practice to connect globally, fostering collaborative networks. Such connections are facilitated through digital tools and infrastructures that encourage the open exchange of knowledge, skills, and best practices as digital commons. By creating dynamic relationships between different scales – blending global connectivity with localised practices – cosmolocal initiatives nurture an ecosystem of adaptable, decentralised projects that aim to "scale wide" rather than "scale up." While several challenges still need to be addressed, cosmolocal scalability presents a promising pathway for fostering new social relationships and modes of production, ultimately laying the groundwork for post-capitalist futures.

Keywords: scalability, cosmolocalism, counter-hegemony, mid-tech, infrastructure

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1. Nonscalability

Anna Tsing's theory of nonscalability serves as a powerful critique of capitalist ideas about progress and growth, shedding light on the consequences of scalability. In her seminal article "On Nonscalability" (2012), Tsing argues that the modern world has been shaped by scalability projects – initiatives aimed at expanding and replicating supposedly successful models without making necessary transformations. These projects, which range from plantation agriculture to industrial manufacturing, rely on standardisation and often lead to the erasure of diversity.

Tsing emphasises the importance of "meaningful" biological and cultural diversity, which can inhibit scalability by requiring projects to adapt to different contexts. In contrast, scalability projects strive to create controllable and frictionless environments for expansion, reducing the intricate complexity of our world to what Tsing calls "nonsoels" – nonsocial landscape elements treated as interchangeable units. Nonsoels are intentionally stripped of their social and ecological connections, designed to function as uni-

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form, self-contained components within a scalable system. Examples of nonsoels include sugarcane clones on plantations, standardised labor units in factories, and even pixels in digital images. By creating these artificial and isolated units, scalability projects aim to eliminate the complexity of real-world interactions.

However, Tsing argues that this process of creating nonsoels is never truly complete, often overlooking or suppressing diversity and relationships that resist such simplification. Such scalability, she posits, is ultimately a seductive fantasy. In all its glorious messiness, diversity, and unpredictability, the real world resists frictionless scaling. Nonscalable elements – ecological, social, or economic – invariably disrupt attempts at seamless expansion. As Tsing puts it, "scalability is not an ordinary feature of nature. Making projects scalable takes a lot of work" (Tsing 2012, 505). This work, she reveals, often involves violence, exploitation, and the erasure of local complexities, painting a stark picture of the true cost of our relentless pursuit of growth.

Tsing's insights provide a compelling explanation for why capitalist scale-at-all-costs models are fundamentally unsustainable (Pfotenhauer et al. 2022). The fixation on scalability damages ecosystems, creates precarity, and is incompatible with the heterogeneous, interdependent nature of life on Earth. Adaptations in living systems proliferate not through deliberate promotion, but because they enhance the survival and well-being of species and their communities. When these adaptations lose their usefulness and become maladaptive, they either fade away or are discarded (Loring 2023). Tsing illustrates this through various examples, including the contrast between sugarcane plantations (an icon of scalability) and matsutake mushrooms (which resist scalable production). She argues for a nonscalability theory that accounts for the complex, transformative relationships scalability projects often ignore or suppress.

Tsing's work also challenges us to rethink our approach to knowledge itself. She points out that much of modern science demands scalability in its research frameworks, potentially obscuring the diversity pertaining to different ways of knowing and living. What seems scalable for scientific, technical, or economic reasons can differ greatly across regions, cultures, and legal boundaries (Pfotenhauer et al. 2022). By recognising the limitations and costs of scalability, we can develop more nuanced, context-sensitive approaches to understanding and interacting with our world.

Yet, as we stand on the precipice of mounting ecological and social crises, a question lingers: Could we reimagine scalability in more sustainable and inclusive ways? Is it possible to spread and replicate positive models without falling into the traps of capitalist scalability projects? This essay argues that an alternative form of scalability is indeed possible and already emerging – a concept we might call "cosmolocal scalability", offering a glimmer of hope in an increasingly complex world.

2. Cosmolocal Scalability

Cosmolocal production offers a novel trajectory of scaling that diverges significantly from traditional capitalist models (Kostakis, Niaros and Giotitsas 2023). This approach emphasises diversity, local adaptation, and open knowledge sharing, contrasting with the rigid standardisation and control typical of conventional scaling methods. The concept of cosmolocal production has emerged alongside the proliferation of digital communication networks (Schismenos, Niaros and Lemos 2020). It describes methods of connecting local communities through networks of shared resources and knowledge, effectively redefining community in terms of place. This is achieved via infrastructures that facilitate sharing knowledge, techniques, and practices over open communication channels.

In practical terms, cosmolocalism enables the localisation of collaborative forms of production while sharing resources globally as digital commons. Several technology initiatives exemplify cosmolocal practices. These include Wind Empowerment (https://windempowerment.org/), developing open-source small-scale wind turbines; OpenBionics (https://openbionics.org/), creating open-source robotic and prosthetic devices; LibreSpace (https://libre.space/), building open-source nanosatellites and other space research equipment; RepRap (https://reprap.org/wiki/RepRap), which focuses on open-source 3D printers; and agricultural projects like L'Atelier Paysan (https://www.latelierpaysan.org/) and Farm Hack (https://farmhack.org/), which develop open-source tools for small-scale farming.

The collaboration and interconnection among initiatives like L'Atelier Paysan from France, Farm Hack from the USA, and Tzoumakers (https://www.tzoumakers.gr/) from Greece, along with other open-source agriculture projects, exemplify this new mode of cosmolocal scalability. Farm Hack's and L'Atelier Paysan's online platforms allow farmers to freely share tool designs and modifications, which other farmers then adapt to suit their specific contexts. These initiatives also facilitate workshops where farmers collaboratively prototype new tools, with designs then shared openly for others to build upon. This approach enables a form of distributed experimentation and innovation. Tzoumakers, a community-driven rural makerspace in mountainous Northwestern Greece (Epirus) in which two of the authors participate, demonstrates this dynamic in action. By connecting with initiatives like Farm Hack and L'Atelier Paysan, the Tzoumakers community accesses a wealth of open-source designs and practices. Rather than simply replicating these, the initiative adapts them to meet the unique needs of local small-scale farmers and other stakeholders while considering regional resources. The tools and methods developed are then fed back into the global commons, enriching the collective knowledge base.

This multidirectional flow of ideas and designs, facilitated by digital platforms but realised through local manufacturing and experimentation, enables these initiatives to "scale wide" or "scale out" rather than "scale up". Besides, upscaling can lead to small initiatives losing their innovation potential (Druijff and Kaika 2021). These cosmolocal initiatives cultivate ecosystems of small-scale, locally-focused communities that are globally connected, nurturing the communal capabilities of individuals and groups, and contributing to the global digital commons. This approach embodies what Ezio Manzini (2015) calls "cosmopolitan localism" (or cosmolocalism), where local systems remain small and comprehensible to individuals and communities, yet are open to global flows of knowledge.

By leveraging the power of networks, these small-scale initiatives can operate effectively in complex, rapidly changing environments, fostering resilience and adaptability. Moreover, this scaling model promotes a new kind of production system where the global becomes a network of locals, as Manzini notes, enabling a harmonious balance between local autonomy and global interconnectedness.

What spreads through this network is not only technical knowledge, but also cultural practices and values. The ethos of open collaboration, autonomy, and ecological stewardship propagates alongside tool designs and manufacturing techniques. These values take root in new locales, creating fertile ground for other cosmolocal initiatives to emerge. This way of scaling represents a profound departure from capitalist scalability, which often erases local cultural practices in favour of homogenisation and profit-maximisation. Instead, cosmolocal scaling cultivates a diverse ecosystem of interconnected yet distinct initiatives; each adapted to its local context while benefiting from and contributing to a global commons (Figure 1).

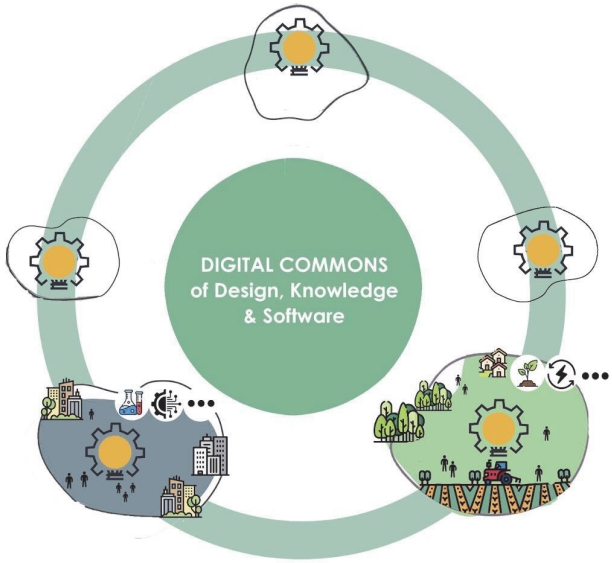

Figure 1: An overview of how diverse locally oriented but globally connected initiatives are linked through shared digital commons. Each bulb (idea/design) with a cog (manufacturing) represents a local commons-based production system. The model shows how knowledge, from agriculture and energy to robotics, can spread globally while being adapted to specific local contexts, ranging from urban to rural settings.

3. "Mid-Tech" for Scalable Production

Cosmolocal production thus emerges as a vibrant thread, weaving together the seemingly disparate strands of global connectivity and local autonomy. This novel approach to manufacturing and design presents a compelling alternative to the monolithic structures of conventional industrial production. At its core, cosmolocal production is defined by at least four key features that set it apart from its industrial counterparts (Kostakis et al. 2018).

First, it embraces design-embedded sustainability, where products are often conceived not just for immediate use, but for longevity and adaptability. This attribute echoes the timeless wisdom of craftsmanship, where objects are created to last and evolve with their users. Second, it promotes on-demand local manufacturing, bringing production closer to the point of use and significantly reducing the ecological footprint associated with long-distance transportation. Third, it employs shared productive infrastructure, where digital and physical tools are communally managed resources, so productive infrastructure is optimised. This sharing extends beyond mere tools to encompass designs and technical information, fostering a culture of grassroots innovation (Troullaki and Rozakis 2024). Fourth, cosmolocal production allows for participant-defined value systems. For example, the members of L'Atelier Paysan decided that the cooperative model better reflects and encapsulates their values. Instead, the members of Farm Hack feel that a more autonomous model of organisation better fits them,

which is why they have established a network organised around their web platforms and physical events that take place from time to time (Giotitsas 2019).

Cosmolocalism combines digital tools with local knowledge and traditional crafts in a “mid-tech” approach (Kostakis, Pazaitis and Liarokapis 2023). It leverages advanced digital design and knowledge sharing tools, while incorporating local expertise and simple techniques. The goal is to create accessible, adaptable, and repairable technologies, reducing reliance on global supply chains and prioritising longevity and ease of maintenance. Examples like a specific version of OpenBionics’ prosthetic limbs, which minimise the use of electronics and utilise the Internet and high-tech software for global design and distribution, as well as open-design agricultural tools from initiatives like L’Atelier Paysan, show how this approach can result in new, affordable solutions that integrate technological progress with ecological sustainability and social inclusion.

The mid-tech approach also challenges the idea that newer, more complex technologies are always superior. Instead, it encourages a critical examination of technological choices, considering factors such as energy efficiency, resource use, and social impact. This approach recognises that sometimes, simpler technologies or hybrid solutions that combine traditional methods with modern innovations can be more effective and sustainable.

This unique configuration allows for a balance that does not reject all technological progress, but rather seeks to harmonise it with local needs and knowledge. Cosmolocal projects thus help us reimagine scalability, moving away from the traditional capitalist model of ”scaling up” to embrace a concept of “scaling wide” or “scaling out”. This alternative trajectory of scalability embraces diversity and local adaptation while still facilitating replication and expansion. In cosmolocalism, ideas, practices, and innovations can spread widely without imposing a homogeneous template, offering a vision of post-capitalist scalability that respects and celebrates the rich tapestry of local contexts and cultures.

4. The Tightrope Walk of Cosmolocalism

The cosmolocal production, while promising, is not without its complexities and challenges. At the heart of cosmolocalism lies a fundamental tension between openness and sustainability. The ethos of free sharing that drives innovation can, paradoxically, threaten the very foundations of these projects (Druijff and Kaika 2021). Corporate entities, with their vast resources, may swoop into appropriate open designs without reciprocating or nurturing the commons from which they benefit. Some initiatives have responded creatively, experimenting with “commons-based reciprocity licenses” that demand commercial users give back to the collective pool (Bauwens and Kostakis 2014). However, the challenge of sustaining open systems in a world still dominated by closed, profit-driven models remains a tightrope walk.

Moreover, the global nature of cosmolocal networks, while a strength, can also mirror and potentially amplify existing inequalities. These networks may inadvertently flow along lines of privilege. Nodes blessed with more time, tools, and expertise may eventually dominate development, drowning out voices from less-resourced regions and groups. For example, most contributors to open hardware projects are white males from Europe and North America.

Further, legal and regulatory frameworks, designed for a world of centralised production and closed intellectual property, often struggle to accommodate the fluid, boundary-crossing nature of cosmolocal practices. Under the current liberal legal land-

scape, digital commons are unable or unwilling to scale (Shulz et al. 2024). For example, open-source hardware and community manufacturing exist in a twilight zone of legality, neither fully embraced nor explicitly forbidden. Navigating this regulatory labyrinth, while simultaneously working to reshape it, remains an ongoing challenge as cosmolocal models seek to move beyond niche applications into the mainstream.

Perhaps the most pervasive challenge is the constant push and pull between cosmolocal principles and the gravitational force of the capitalist economy in which these initiatives exist. Cosmolocal projects must constantly resist the pressure to drift towards more conventional business models or risk being swamped by corporate competitors. Maintaining fidelity to commons-based principles in the face of relentless market pressures requires commitment and creative strategies for economic sustainability.

Moreover, the engine of many cosmolocal projects – volunteer enthusiasm and labour – is a source of strength and potential fragility. While passion fuels innovation, it can also lead to burnout, threatening the long-term viability of projects. Developing robust models for sustaining engagement and fairly compensating labour remains a critical challenge. Some initiatives are charting new territory, and exploring novel cooperative structures and alternative revenue models that align with cosmolocal values.

5. De-Coupling Critical Infrastructure

Cosmolocal production depends on access to critical infrastructure. At the local level, we find that shared infrastructures like makerspaces are adaptable to different contexts. In the case of digital infrastructure, it is crucial to acknowledge a fundamental tension at its core: the dependence on large-scale infrastructures such as the Internet and its energy-intensive materiality. This dependence creates a paradox where initiatives striving for local autonomy and sustainability remain tethered to global systems that may not align with their values or long-term goals.

The Internet, comprising a vast network of servers, cables, and data centres, functions as the nervous system of cosmolocal production. It facilitates the global sharing of designs, coordinates distributed manufacturing, and fosters the creation of transnational communities of practice. However, similar to infrastructures like railroads, this digital commons is often constructed and maintained by corporate entities. It also relies on resource-intensive processes that can contradict the ecological goals of many cosmolocal projects (Muller 2024). This discrepancy raises important questions about the viability and integrity of cosmolocal models in their current form. How can we align the ideals of local empowerment and ecological sustainability with a reliance on centralised, energy-intensive digital infrastructure? What potential pathways exist for cosmolocal initiatives to evolve and reduce this dependence?

Addressing these challenges will require multi-faceted approaches and long-term strategic thinking. Several potential avenues for development merit exploration. Developing less energy demanding digital communication technologies could reduce the ecological footprint of cosmolocal networks. This might involve revisiting and updating older technologies or creating novel low-power solutions. Efforts to create more distributed, community-owned internet infrastructure, such as mesh networks, could align digital communication systems more closely with cosmolocal principles. Projects like Althea (https://hawknetworks.net/) and Guifi.net (https://guifi.net/) offer promising models for community-controlled Internet provision.

Further, while existing satellite Internet networks are predominantly owned and operated by private corporations, there is evidence that communities can also create and manage orbital space technology (Lemos and Giotitsas 2021). In addition to Internet

connectivity, satellite-based infrastructure may play a crucial role in addressing sustainability challenges on Earth (Yap and Truffer 2022). Earth-orbiting satellites provide real-time data, revealing the negative environmental impacts of "scale-at-all-cost" approaches. This data can assist local decision-making in areas such as agricultural monitoring, urban planning, and industrial development.

Shaping policy to support more democratic control of digital infrastructure could help shift the balance of power. This might include mandating open access to physical infrastructure or supporting community broadband initiatives. Broadening the scope of open-source development to encompass more of the digital infrastructure stack could reduce dependence on proprietary, corporate-controlled systems. A long-term strategy of progressively localising production and its supporting digital infrastructure could help cosmolocal initiatives align practice with principles over time.

The current incarnation of cosmolocal production represents an intermediary stage – a hybrid model that leverages existing global infrastructure to nurture more localised, sustainable practices. As these practices evolve and mature, they may develop the capability to reshape or replace the same infrastructures they currently depend upon. This process will likely be gradual and uneven, with different regions and sectors progressing at varying rates. It will require ongoing experimentation, learning, and adaptation. The challenge for practitioners and theorists of cosmolocal production is to remain clear-eyed about these dependencies and limitations while working steadily towards more fully realised versions of their vision. By confronting this paradox openly, the cosmolocal movement can strengthen its theoretical foundations and practical strategies. It can spur innovation in less unsustainable digital technologies, inspire new forms of community ownership, and contribute to broader discussions about the future of our shared digital infrastructure. In doing so, cosmolocal approaches may not only transform production but also help reimagine our global collaboration networks.

Cosmolocal scalability is not a fully realised alternative system, but an emergent and experimental set of practices. It is a work in progress, still grappling with how to interface with and potentially transform dominant economic and regulatory paradigms. Cosmolocal initiatives also serve as incubators for post-capitalist practices, experimenting with more democratic and degrowth or post-growth economic models. As cosmolocal networks develop, they could facilitate the rapid adoption of ecological production modes, addressing planetary-scale sustainability challenges through global knowledge sharing and local adaptation.

6. Charting a Course for Post-Capitalist Construction

Tsing's critique of capitalist scalability highlights its implications and contradictions as being fundamentally at odds with ecological and social realities. Despite the backdrops, the relentless pursuit of frictionless scaling not only exists within business and science-related settings, but also appears in social innovation and public policy debates and research programs (Pfotenhauer et al. 2022). Yet, in a world facing overlapping crises, the need for alternative ways to spread positive innovations and practices is urgent. While traditional approaches to scalability prioritise speed, disruption, and homogeneity, cosmolocal scalability arguably offers an emergent alternative trajectory that points toward more democratic, inclusive, and sustainable modes of production.

Cosmolocal scalability represents a different approach to scaling, viewing scales (local, regional, or global) as neither fixed nor hierarchical (Grillitsch et al. 2024). Rather than merely shifting activities from one vertical scale to another, this approach emphasises the active, intentional, and purposeful engagement of actors in reshaping scalar boundaries to more effectively interact with and influence social, economic, and

political processes (Grillitsch et al. 2024). Central to this process is the concept of human agency — the capacity of individuals to make tangible impacts on the world (Gregory et al. 2010) — enabling them to transform existing structures and underlying rationales over time, even as they operate within established frameworks (Grillitsch et al. 2024).

Drawing on Antonio Gramsci's (1971) thought, cosmolocal scalability could be seen as a potential avenue for building counter-hegemony against capitalist modes of production and expansion. Gramsci emphasised the importance of ideological struggle in civil society as a precursor to transforming political and economic structures. Cosmolocal initiatives can become sites for developing new "organic ideologies" that could challenge capitalist notions of scarcity, competition, and endless growth.

The global networks of cosmolocal projects could be understood as nascent forms of what Gramsci called a "collective will" – a shared vision and set of practices that unite diverse groups in pursuit of systemic change. By fostering direct participation in the design and production of goods, cosmolocal approaches may help overcome the alienation inherent in capitalist production, creating more engaged and empowered citizens.

Crucially, cosmolocal models align with Gramsci's strategy of building counter-hegemony through a "war of position" rather than a frontal assault on state power. By creating alternative economic practices and fostering new forms of social relations within the interstices of the existing system, cosmolocal initiatives can gradually erode the legitimacy and perceived inevitability of capitalist modes of production. The role of "organic intellectuals" is vital in this process. Designers, engineers, and community organisers involved in cosmolocal projects can serve as these organic intellectuals, articulating new visions of production and social organisation rooted in the practical experiences of their communities. Their task is not only technical but deeply political and cultural – helping to forge new common sense around ideas of value, work, and human flourishing.

To be sure, cosmolocal models face significant challenges and tensions as they interface with dominant systems. They should not be uncritically celebrated as a fully-formed alternative. But they offer vital spaces of experimentation for post-capitalist practices. As Gramsci recognised, building a new hegemony is a long-term process that requires patience, strategic thinking, and the ability to work across diverse sectors of society. Cosmolocal scalability is not just a technical shift but a cultural one. It involves different ways of relating, collaborating, and conceptualising value. As such, it connects to broader movements for economic democracy, ecological sustainability, and social justice. The task ahead is to consciously develop these connections, creating what Gramsci called a "historic bloc" – an alliance of social forces united around a common transformation project.

Looking forward, proponents of cosmolocal approaches must grapple with several key challenges. These include developing robust economic models that can sustain and expand these initiatives while resisting co-optation by capitalist logic, and bridging divides between urban and rural contexts, as well as between the global North and South, to create genuinely inclusive collaboration networks. Another vital task is engaging with policymakers and institutions to create legal and regulatory frameworks that support, rather than hinder, commons-based production. Additionally, cultivating new education and skill-sharing forms can spread the technical and social knowledge needed for cosmolocal production. Building alliances with labour movements, ecological movements, the open-source movement, the cooperative movement, and other

progressive forces is essential to situate cosmolocal practices within broader struggles for systemic change.

By addressing these challenges, the cosmolocal movement may move beyond isolated experiments to become a significant force in shaping post-capitalist futures. As Gramsci reminded us, fundamental social change requires both pessimism of the intellect – a clear-eyed assessment of current realities – and optimism of the will – the determination to create alternatives even in the face of daunting odds. Cosmolocal scalability, with its blend of technological innovation and social reimagining, offers one promising path forward in this crucial task.

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Appendix 2

Publication V

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A Look at the Commons through the Lens of Buddhist Ethics

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Abstract

This chapter discusses the commons through the lens of Theravada Buddhism and reflects on their relation regarding ethics and practice. First, we introduce the commons as a social system of self-organization and governance and as a way of sustainable living observed in both traditional and contemporary contexts. Simultaneously, informed by practiced examples of Buddhist commons from Cambodia, we highlight how the commons find culture-specific expressions and are compatible with the Buddhist tradition. Specifically, focusing on the Right Livelihood *(sammā-ājīva)* from the Noble Eightfold Path of the Pali Canon, we discuss how Buddhist ethics – i.e., interconnectedness, moderation, compassion, and generosity – align with the collaborative nature of the commons. Through the comparative understanding of both Buddhist and Commons' perspectives, we aim to contribute to the relevant literature that challenges the unsustainable global-Western paradigm of economic growth and individualism.

Keywords: Commons; Self-interest; *Saṅgha*; Interconnectedness; Buddhist Economics.

Introduction

The dominant institutions encompassing the mainstream approaches to governance and economics are premised on the Western worldview, imposed across the globe through colonization, modernization, and globalization. However, an evolving discourse highlighting the global-Western trajectory's defects calls for alternative pathways toward more sustainable and just futures. The commons play an important role in this discourse. Another notable perspective is related to Buddhism. Attention on Buddhist governance and economics relates to the re-popularized intersection of religion and governance (Ongaro & Tantardini, 2023a; 2023b), focusing on Buddhism as a world religion (Habermas, 2019) and its relevance in and for secular contexts. Additionally, the Buddhist approach is popular within the critical discourse on sustainable development, economics and politics for its potential to challenge established institutions (Drechsler, 2019; King, 2016; Long, 2019; 2021; Verma, 2017).

Recognizing the growing interest in these two branches of the aforementioned discourse, this chapter explores the relationship between the commons and the Buddhist approach to governance and economics, tracing similarities in their ethical and organizational aspects. We consider these similarities pivotal in discussing non-Western alternatives for more equitable and sustainable futures, transcending the individualistic and growth-oriented Western trajectory.

This chapter approaches the commons as a system of collective self-organization for managing and producing shared resources through commoning practices (Bollier & Helfrich, 2019), motivated by radically different incentives from self-interest and profit maximization. Recognizing the inherent interconnectedness of social and living systems, the commons approach is premised on ethics of care for ecological stability and the well-being of present and future generations on a planetary level. In a similar vein, key elements of Buddhist ethics, rooted in the teachings of the Buddha (c. 480-400 BCE), include interdependence, compassion, mindfulness, non-violence, and profound respect for all living beings and the environment (Harvey, 2000; Keown, 2016). Buddhism emphasizes the interdependent nature of our world and stresses the need for compassion and non-violence in our dealings with shared resources (Brown, 2017; Ng, 2020). Furthermore, mindfulness, a cornerstone of Buddhist practice, encourages conscious decision-making and an increased awareness of the consequences of our actions on the common resources. More importantly, Buddhism advocates for equity and justice, as seen in the principles of fairness and the alleviation of suffering (Jayasuriya, 2008; San, Drechsler, & Shakya, 2023). In this light, we posit that the commons resonates with the core Buddhist principles from an ethical perspective.

Furthermore, commons are viewed as a context-adaptive system, a pattern or template for organization and governance, that manifests in various ways within different local realities and cultural contexts (Bollier & Helfrich, 2019). These variations, however, share the same ethical foundation. There are no universal models that define exactly how ventures based on the commons should be created and operated; each example is unique (Bollier & Helfrich, 2019).

Similarly, there is no blueprint on how the Buddhist canon should be implemented and institutionalised, resulting in a variety of religious customs, practices and adaptations in governance systems in Buddhist countries, according to different local and socio-historical contexts (Drechsler, 2020; Jayasuriya, 2008; Koeuth, 2016). Hence, from an organisational perspective both the commons and Buddhism may be viewed as context-adaptive systems that retain a solid ethical foundation. The adaptability of commons and Buddhist institutions and similarities regarding their ethical core led us to discuss their intersection as a contribution to the relevant discourse.

Additionally, although the commons as institutions of collective governance have had a significant presence throughout human history, the domination of the Western worldview has marginalized this social practice. The culture of the commons and our collective memory of it have been supplanted by the Western monoculture (Bollier, 2014), promoting individualism, imposition on nature, and a specific interpretation of progress and growth. There are cases, however, where the commons still manifest in social and everyday affairs. We argue that this holds true for Cambodia, where the Theravada Buddhist ethic continues to be fundamental to society, notwithstanding Western influence. In this direction, we focus on the Cambodian context, discussing three examples that describe how the community organizes and manages shared resources to cover spiritual and everyday needs. We approach these examples as commons-based institutions and thus refer to them as cases of 'Buddhist commons'.

The methodology involves a two-fold approach. First, we reviewed existing literature on the commons and Buddhist approaches to investigate their intersection. To delve deeper into the question of Buddhist ethics and governance, the chapter relied on the Sutta and Vinaya texts, which were initially translated from the Pali texts by different scholars. Second, we conducted semi-structured interviews with Khmer *saṅgha* members, abbots, *sālā-samnak* representatives, scholars, and experts in Khmer Buddhism and tradition in three provinces/capitals: Battambang, Siem Reap, and Phnom Penh. The selection of interviewees, comprising 20 individuals, on and off the record, was based on their involvement in Buddhist socially engaged activities and the field of Buddhist studies. During these interviews, questions were asked concerning the significant roles of "*sālā-punya/dhamma-sālā*, its foundational principles, and the decision-making process regarding the governing body and the engaged activities of *sālā-punya/dhamma-sālā,* etc." We then employed a discourse analysis approach to analyze the interviews and derive insights into the practices and perceptions surrounding the commons practice of the Buddhist community in Cambodia. This comprehensive methodology enabled us to better understand how Buddhist commons function in the Cambodian case, gaining insights for the broader discussion on alternative pathways of governance and economics focusing on the commons' potential.

The Intersection of Buddhist Ethics and the Commons

Buddhism began on the Indian subcontinent in the fifth century BC as a small religious community that developed a certain distance, both self-perceived and realization, from other contemporary religious communities of the time (Reynolds and Hallisey, 1987). From the earliest date, there were signs of an emerging commons practice in the Buddhist community regarding the decision-making process, governance, and the recruitment of new members into the *saṅgha* community through open participation.

The main goal of joining the *saṅgha* community is to liberate oneself from worldly attachment and to pursue awakening by living a dedicated life of spiritual practice. However, this goal often leads to its characterization as an 'otherworldly' religion with a gnostic aversion to worldly matters, sparking debates about its level of social engagement (Harris1989b). In Weber's 1916 analysis of the comparative sociology of Indian religions, he denied the relationship between early Indian Buddhist traditions and social-economic engagement. Weber portrayed the belief systems in India, including Buddhism, as 'otherworldly' religions that emphasize individual salvation over social responsibility.

The view of Buddhism as 'otherworldly' leaves its social role, economic engagement, and organization largely unexplored (Atwood, 1996; Hamilton, 1998). In theory and practice, Buddhism is widely seen as an essential source of non-profit activity and social welfare. The end goal of Buddhism is, of course, to achieve *nirvana,* a state of liberation from worldly attachment, however, the *saṅgha* community does not entirely detach themselves from worldly matters. The principles, practice, and governance of the Buddhist community especially the *saṅgha* are rooted in open participation, shared purposes and resources, mutuality, and fairness which can be viewed as a sign of social engagement or the commons.

It can be assumed that the Buddha views the ways of living and governing society are different from Machiavelli (1469–1527), an Italian philosopher, writer, and politician, who emphasizes the importance of identifying one's other weaknesses and vulnerabilities and how one can exploit them and use them to one's advantage. In *The Prince*, Machiavelli (1532, p. 91) warns that evil prevails even when someone wishes to adhere solely to virtuous principles.

In a similar argument, Smith (1723-1790), a Scottish philosopher and economist, asserts that human action and decisions are driven by self-interest because most people strive to maximize their happiness, well-being, or success, even at the expense of others. According to Smith, the individualistic nature of humans fosters competition, motivating producers to reduce prices and improve the quality of their products by increasing efficiency and innovation, contributing to economic growth; thus benefiting all members of society, including the poorest.

Like Smith, Hardin (1915–2003), an American ecologist, argues that humans are inherently self-interested, and that this self-interest drives much of their behavior. Particularly, in situations where a resource is held in common and there are no clear rules or regulations for its use, self-interest urges people to exploit the resource until it is exhausted. In *The Tragedy of the Commons*, Hardin (1968, p. 1244) argues that individuals benefit personally from their ability to ignore the truth, even though it may harm society as a whole. Ultimately, this understanding of

behavior results in the collapse and tragedy of the commons. As Hardin suggests, a solution to this problem is the enclosure of resources through government regulation and private ownership. Enclosure, he argues, could prevent the depletion and overuse of resources by creating individual incentives to conserve them.

Premised upon such assumptions is the dominant global-Western trajectory, according to which economic growth is a prerequisite for the social prosperity (Pansera & Fressoli, 2021). Typical mechanisms to achieve economic growth include the enclosure, privatization, commercialization, and central governance of common resources; efficiency-oriented industrial production; and unilateral technological progress. These mechanisms prioritize monetary profit maximization and have profound consequences related to social inequalities, the environmental crisis, and the extinction of cultural diversity. Despite the acknowledged defects currently posing an existential threat to humans and non-humans alike, the Western trajectory continues to prevail as the only alternative. Nevertheless, adherence to the homogenizing and fragmentary logic of this trajectory has long been a subject of controversy.

A notable critique towards the mainstream perspectives is Schumacher's work on Buddhist Economics, which gained widespread attention following the publication of his book *Small is Beautiful: Economics as if People Mattered* in 1973. The book presented Schumacher's alternative economic theories that critiqued mainstream Euro-American economic thinking and proposed alternative development models for Asia and the West. Schumacher's theories emphasize human-scale technologies, decentralization, and the sustainable use of natural resources aligned with the Buddhist perspective, shedding light onto the social, political and economic aspects of Buddhism. As opposed to Adam Smith, who emphasizes the role of self-interest in promoting economic growth, Schumacher argues that pursuing self-interest in a free-market system might lead to exploiting workers and the environment. Rather than maximizing profit, Schumacher claims that economic development should not be driven by self-interest alone but instead be based on ethical values and sustainable principles to serve the needs of the people.

Schumacher's self-interest argument is well aligned with the concept of *anattā*, meaning non-self in Buddhism, referring to the concept that no permanent, unchanging self or soul is found in any human being. In Buddhism, all phenomena, including individuals, are impermanent and constantly changing, and none possess an inherent or intrinsic self-nature. The *anattā* principle aims to encourage Buddhist practitioners to detach themselves from the misguided clinging to what is mistakenly considered to be *self,* and through that detachment (alongside moral livelihood and meditation), the path to *nirvana* – a state of liberation from the cycle of suffering – can be successfully traversed.

From a different viewpoint, Payutto (1992, p. 25), a well-known scholar in Buddhist Economics, views self-interest as a natural aspect of human behavior, and thus the driving force of competition in mainstream economics. However, Payutto emphasizes that competition must not be pursued at the expense of others or environmental degradation. According to Payutto, such competition is driven by *taṇhā* (sensual desire), considered a leading cause of suffering and an unwholesome state in Buddhism. Therefore, Payutto (1992, p. 57) stresses that human behavior is also driven by *chanda,* or willingness, regarded as a wholesome state for bringing about real

well-being or quality of life. He continues to address that all individuals have a moral responsibility to act in a way that does not harm others or the environment; since non-harming and the idea that moral actions have consequences *(karma)* over human existence are essential aspects of Buddhist teachings (Payutto, 1994; Keown, 1996).

Based on the doctrine of *karma,* one of the central teachings in Buddhism, every action has consequences (Rahula, 1959; Harvey, 2000). According to Buddhism, *karma* is not just an inheritance from a past life that determines and dictates one's fate. Buddhism points out that *karma* originates from the threefold nature of one's daily activities: bodily action, verbal action, and mental action, accompanied by the pulling feeling of volition (Ghose, 2007). Therefore, Buddhism emphasizes that moral actions have consequences, affecting individuals and the states of affairs brought into being through moral acts (Keown, 1996).

Rooted in the theory of *paṭiccasamuppāda*, or the theory of Indra's Jewel Net in Mahayana Buddhism, more precisely translated as "dependent origination" or "dependent co-arising," all things arise in dependence upon other things,[1] meaning that nothing can stand on its own (see Payutto, 1994; Keefe, 1997; Thanissaro, 2013a). According to this theory, Buddhism views the world as a vast interconnected web of events, where each phenomenon constitutes and reflects other phenomena. The *paṭiccasamuppāda* theory or the theory of Indra's Jewel Net provides an idea with powerful ethical and political implications: "If we are all part of a vast, interdependent network of being, what we do can have profound effects on others as our actions reverberate throughout this network" (McMahan, 2008, p. 132). The doctrine demonstrates that every action has its consequences. These consequences first affect the individual who performed the action and then extend to the people around them and society as a whole. The interconnected nature of reality, means that '[o]ur ethics—and the behavior that naturally flows from our ethics—contribute to the causes and conditions that determine who we are, the kind of society we live in and the condition of our environment' (Payutto, 1994). To understand connectedness is the key to imagine a different vision for politics (Long, 2021).

Known for her research on collective action and common-pool resources (CPRs), Ostrom challenges the conventional view that individuals are always motivated by self-interest and that common-pool resources (such as fisheries, forests, and irrigation systems) are destined to be overused and depleted without centralized government regulation or privatization. Ostrom argues that Hardin's perspective is oversimplified and fails to consider the complexity of human behavior and social systems. Despite potential conflicts of interest and the possibility for opportunistic behaviors to arise within commons-based institutions, Ostrom's work, informed by hundreds of cases from around the world, asserts that individuals can act in the interest of the group or community, self-organize their own systems of commons-based governance, and develop a cooperative ethic to manage shared resources and achieve shared goals (Ostrom, 2015). Similarly, Benkler (2006; 2011), referring to cases of commons-based peer-production (CBPP), such as Wikipedia, or Free/Libre and open-source-software (FLOSS), explains that

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[1] See *Vera Sutta: Animosity (AN 10.92),* translated from the Pali text by Thanissaro (2013a), available online at www.accesstoinsight.org

people have a natural inclination towards collaboration, which can counteract individualistic and self-interested behavior. Evolutionary scientists also support this tendency (Bollier, 2014).

To address the ambiguity of the term (Hess, 2008), this chapter defines the commons as a social system whereby a community self-organizes and co-devises protocols, values, and norms to manage and maintain shared goods and resources; or collectively produce goods and services. These encompass natural resources and a wide array of tangible and intangible human creations (e.g., data, software, archives, techniques, knowledge, and cultural heritage) (Bauwens et al., 2019; Bollier & Helfrich, 2019; Hess, 2008; Lekakis, 2020). The commons ensure access to these resources, goods and services, and to infrastructures and decisions. This approach stands in stark contrast to exclusive control, whether by private entities or the state, where access can be potentially excluded (particularly considering that the presence of influential economic interests in the public sphere further complicates the idea of public ownership).

The commons is framed by values radically different from those of the market economy, promoting ethics of sufficiency economy, stewardship and knowledge sovereignty (Bollier, 2014; Bollier & Helfrich, 2019; Kostakis & Pazaitis, 2020). Beyond monetary thinking and exchange value, trust, reciprocity, and relationality are put forward (Mandalaki & Fotaki, 2020). At its core, the commons logic recognizes our corporeal vulnerability, and our dependence on each other and nature; while stressing the need to acknowledge that building our lives upon the destruction of ecosystems, the exploitation of resources, and the suffering of others, will only keep things on the same damaging track they currently are (Bollier & Helfrich, 2019; Mandalaki & Fotaki, 2020). Put differently, the commons emphasizes interconnectedness, and calls for taking responsibility of our actions. As Bollier (2014) explains, in its deepest reaches, the commons extends beyond economics, public policy, or politics, indicating a distinct mode of human existence (ontology) compared to those we are accustomed to.

Despite being characterized as an ‘otherworldly’ religion with a gnostic aversion to worldly matters, sparking debates about its level of social engagement, emphasizing individual salvation over social responsibility (Harris,1989b; Weber, 1958), according to mainstream approaches, Buddhism is primarily discussed as a set of ethical guidelines on how to lead one’s life towards liberation (Koeuth, 2016) and the commons as a mode of organization and governance (Mandalaki & Fotaki, 2020), both expand to ontological and political spheres. There are no rigid rules on how to implement and institutionalize the Buddhist canon, nor a blueprint of how commons ventures should emerge. Both cases, however, are strongly tied to a solid ethical core that emphasizes the notion of interdependence point towards justice, sustainability, and human flourishing. The soft adaptable character of commons- and Buddhism-based institutions anchored in similar ethics for socio-ecological prosperity, has allowed a variety of renderings and ventures to emerge in compliance with local and cultural contexts, community needs, and visions.

Next, we explore three examples of institutions from Cambodia, where Theravada Buddhism is integral to society and everyday life. These examples describe how the religious community self-organizes and manages shared resources to cover spiritual and everyday needs. On one hand, these examples of Buddhist institutions comprise a context-specific implementation of the Buddhist canon. On the other hand, they demonstrate a way of governance that resonates with

the organizational aspect of the commons. In this light, we look into these institutions through the lens of the commons, understanding them as secular, context-specific adaptations of commons-based organization, and thus refer to them as 'Buddhist commons'.

The *Saṅgha* Community

Among the three cases of the commons that we discuss here, the *saṅgha* community is one of the significant cases. The reason that the *saṅgha* community is relevant here is that the element of the commons emerges in the daily practice and the community governance. The *saṅgha* is a monastic community and fundamental institution in Buddhism, comprising male-ordained and female-ordained communities, who renounced worldly attachments and committed themselves to the pursuit of spiritual awakening by living a dedicated life of spiritual practice, study, and service. The term *'saṅgha'* is a Pali term meaning an 'assembly,' 'association,' 'community,' or 'order' and is most commonly used to refer to an order of Buddhist monks or nuns (De L, 1970; Buswell et al., 2014; Borchert, 2017).

The *saṅgha* community is governed by a set of monastic rules, which provide ethical guidelines for their daily practice, and create a space for the commons to emerge. In principle, the *upajjhāya,* spiritual preceptors, occupy the highest position in the *saṅgha* community, however, there is no absolute power over the governing or the decision-making process in the *saṅgha* community. The decision-making process is open to all *saṅgha* members regardless of their seniority or status. For instance, in the recruitment of any new members, the *saṅgha* community embraces the bottom-up approach that is contrary to top-down or authoritarian approaches; it therefore works toward inclusivity through consensus decision-making (Dutt, 1924; Jinananda, 1961; Prebish, 2018; Monychenda, 2022).

In the process of joining the *saṅgha* community, the candidate seeks the approval of the chief of the *saṅgha* community. The approval needs to be done through the collective decision, requiring no fewer than ten *saṅgha* members, except in bordering regions, where the monastic rules allow the higher ordination to be held in the meeting of four *saṅgha* members (Dutt, 1924, p. 147; Dickson, 1963, p. 14). Before deciding to accept the candidate into the *saṅgha* community, two mentors are appointed by the spiritual preceptor to assess the candidate's background. Once the investigation is completed, the mentors verbally propose the candidate's ordination three times to the assembly of *saṅgha*. In the absence of objections, silence is expected from all present. However, if an objection arises, it necessitates a vocal expression, and the process will be repeated until a consensus is reached. Likewise, appointing individuals to positions of responsibility, such as inventory manager, requires the endorsement of the members residing in the temple. Moreover, these appointments are bound by a stringent legal process, as stipulated in the sacred scriptures (Monychenda, 1998, p. 10).

If one *saṅgha* member is very sick and unable to join the meeting in person, he must remain outside the boundary of the monastery, or he may send his consent through the other, which is called *chanda* in Pali term, as a sign of pre-agreement with the decision made by the monastic

community. Any decision made without even one monk's presence is invalid (Dutt, 1924, p. 146). In response to the severity of a given issue in the *saṅgha* community, the decision-making process needs to be held through the proper performance of *saṅgha-kamma* (the *saṅgha's* formal act). *Saṅgha-kamma* (see Figure 1) is employed for various purposes, such as reaching agreements, making decisions, or taking actions within the *saṅgha* assembly, which comprises the following requisites (Dutt, 1924, p. 125):

1. The presence of the proper number of competent *saṅgha* members
2. The conveyance of all absentee ballots
3. The motion being proposed
4. The proper proclamation of the proposed act

Figure 1 *The Saṅgha performing Saṅgha-kamma at Wat Bo Temple in Siem Reap City, Siem Reap Province, Cambodia (Source: Facebook Page: វត្តរាជបូណ៌ ក្រុងសៀមរាប)*

Monastic life is set up as a ruling system in which leaders are chosen by their qualities and with the approval of the *saṅgha* assembly. Each *saṅgha* member is required to participate in maintaining the stability of the rule of law of the monastery, i.e., participating every two weeks in a ceremony known as *uposatha* (bi-weekly meeting) in the monastery to review compliance with the monastic code. In the Mahāparinibbāna Sutta (DN 16 – Thanisssaro, 2013b), the Buddha lists seven conditions that will maintain the unity and solidarity of the *saṅgha* community. The first two are these: "(1) As long as the bhikkhus meet often, meet a great deal, their growth can be expected, not their decline. (2) As long as the bhikkhus meet in unity, adjourn from their meetings in unity, and conduct Community business in unity, their growth can be expected, not their decline" (DN 16 – Thanissaro, 2013b).

The *uposatha* observance was formulated to fulfill these purposes, serving as a bi-weekly opportunity for the *saṅgha* assembly to gather, update their membership rolls, address issues, and reaffirm their common adherence to the monastic code (Thanissaro, 2013c, p. 1098). This practice is also observed in the Ostrom Design Principles, particularly in the collective-choice arrangements to ensure that those affected by the rules can participate in modifying them (Ostrom, 2008, p. 224). Performing *uposatha* with an incomplete or divided *saṅgha* assembly is regarded as wrong-doing according to the monastic code. Therefore, the first duty is to convey consent and purity on behalf of a *saṅgha* member who cannot attend the *uposatha* observance. In the Mahāvagga,[2] the Buddha instructed that a sick *saṅgha* member, unable to participate in the *uposatha,* should communicate his consent and purity through another *saṅgha* member to those attending the *uposatha*. According to the monastic code,[3] any *saṅgha* member who witnesses another monk's transgression but fails to report it to the *saṅgha* assembly is also considered to be committing an offense (Rhys-Davids & Oldenberg, 1881, p. 33; Ñāṇatusita, 2014, p. 174). Monitoring and sanctioning, as Ostrom (2008, p. 224) points out, are core principles for communities to sustainably and equitably govern their commons.

Overall, the *saṅgha* in Buddhism lives together as a community, pursuing liberation by adhering to the rules and regulations set forth by the Buddha to maintain continuity and unity within the *saṅgha* assembly. Unity, purity, and integrity are regarded as key factors in preserving the *saṅgha* institution. Democracy or a consensus-based approach is used to make decisions, reach agreements, and act within the *saṅgha* assembly through *saṅgha-kamma* performances. While the primary purpose of joining the *saṅgha* is to liberate oneself from worldly attachments, the *saṅgha* typically remains connected to lay society because their daily basic needs rely on it, and they also have duties as the *dharma* messengers, to disseminate and teach the principles of *dhamma* to lay society.

The Buddhist Temple ***(Wat)***

In Khmer Buddhist community, the term *wat* (see Figure 2) refers to a monastery, pagoda, or temple. A *wat* serves as a residence for the *saṅgha* members and, at the same time, also functions as a center for spiritual practice, cultural heritage, and community activities. If we were to ask whether a Buddhist temple belongs to someone, undoubtedly, no one would dare claim ownership of a Buddhist temple in Cambodia. According to a report released by the Ministry of Cults and Religions in 2022, there are 5,104 Buddhist temples in Cambodia (FreshNews, 2022). Of the 5,104 temples, some are newly established, while others proudly bear a history of four to five centuries.

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[2] Mahāvagga, Khandhaka II, Chapter 22, translated from the Pali text by Rhys-Davids & Oldenberg (1881, pp. 274-5).

[3] In the Suddhika-pācittiya: Requiring of a Transgression for Purification

Buddhist Temple is regarded as common property, generally recognized as collective assets established and maintained by the Buddhist community under the guidance of the *saṅgha* community and the temple committee. Their primary purpose is to serve the common good within their respective communities. This characteristic may account for the prevailing sentiment among the public that the temple is akin to an integral part of their home and enhances a sense of community belonging, even though they do not reside there directly.

The *saṅgha* community relies on donations from the laity. Alongside meditation and virtuous practices, donating land or other material necessities to the *saṅgha* community is an act of accumulating merit in Theravada Buddhism. Furthermore, donation is also viewed as a form of renunciation within the Buddhist belief, signifying a virtuous act—a means to sever one's attachments to worldly possessions and to be free from greed (Falk, 2007, p. 140). When understood in this light, *saṅgha* members are not expected to reciprocate in any manner. Tambiah (1970, p. 213) referred to this as 'a double negation of reciprocity': on the one hand, the donor can liberate themselves from worldly attachments, and on the other, the recipient is not obliged to 'repay' following the customary logic of gift exchange, as described by Mauss ([1925] 1990), or adhere to the *quid pro quo* principle found in commercial transactions.

Building upon Tambiah's concept of the 'double negation of reciprocity' (1970, p. 213), Strenski (1983) elaborates that as the *saṅgha* community receives productive lands and durable items, it manages these assets to 'enrich society at large.' Consequently, the *saṅgha* community doesn't directly reciprocate the donors but indirectly benefits a third party, eventually returning benefits to the original donor (Strenski, 1983, p. 473). Strenski's 'circle of giving' concept provides a lens for understanding how Buddhist temples function as a commons.

Figure 2 *Roluos Temple in Roluos Commune, Prasat Bakong District, Siem Reap Province, Cambodia (Source: Author)*

All donations received by the *saṅgha* community from the laity are considered common property, meant to be shared and accessible to all members of the community. These objects are

known as *garubhandha,* meaning ‘heavy objects’ or ‘expensive goods.’ This pedagogical term encompasses a diverse array of equipment and donations generously offered by lay followers to the *saṅgha* community in the temple. The concept of ‘heavy objects’ goes beyond their mere physical weight; it also signifies the substantial responsibility of effectively managing and judiciously allocating these communal resources, embodying principles of equity and justice.

Garubhandha cannot be owned by any individual *saṅgha* member or given from one *saṅgha* member to another. The *garubhandha* property is designated for the *saṅgha* community, reflecting its collective ownership and responsibility. However, the *saṅgha* community may choose to temporarily loan *garubhandha* to others, ensuring its utilization benefits the wider community's welfare and needs. Through this thoughtful management of shared assets, the *saṅgha* community upholds the values of compassion and interconnectedness, reflecting the teachings of the Buddha.

The Buddha enacted many relevant laws to avoid exploiting common property to serve personal interests. For instance, the *saṅgha* members are prohibited from treating common property as their personal property. Instead, if a monk requires the use of such belongings, they may borrow or exchange them for items of equal value with the consent of the *saṅgha* community. Moreover, any *saṅgha* member who dares to hand over this common property to another individual, be it a fellow *saṅgha* member or a devotee of the temple, without the consent of the *saṅgha* community will be fined as prescribed by the rules and regulations outlined in the books of discipline.

The *Sālā-Samnak*

Beyond the *saṅgha* community, other expressions of the commons are observed within the lay Buddhist community. *Sālā-samnak* is a gathering place for lay Buddhists to engage in various activities, such as doing charity, community meetings, hosting festivals, and organizing ceremonies. *Sālā-samnak* means a rest house in Cambodian, traditionally built by villagers on the roadside as a rest stop for travelers and passersby. S*ālā-samnak* is normally found on either side of the road but never far from the village.

The construction of *sālā-samnak* is an old tradition in Cambodia. This tradition became even more important when King Jayavarma VII (c. 1122–1218) came to power. According to one of our interviewees, Ang Choulean, a Khmer anthropologist and a professor of historical anthropology at the Royal University of Fine Arts based in Phnom Penh, the idea of building a resting house in the Khmer Empire might have existed even before the reign of King Jayavarma VII; however, its implementation was scattered and unsystematic. King Jayavarma VII was the one who put it into state policy and made it more systematic based on the principles of Buddhism. From the verses 122-126 of the inscriptions on Preah Khan stele dated from 1191 CE, we learn that the King built 121 *sālā-samnaks* on the main roads leading from the Angkor capital, Yasodharapura, to distant areas. There were 57 rest houses with fire as staging posts along the road from Yasodharapura to the city of Campā, which is now located in Vietnam; and

17 rest houses along the road from Yasodharapura to Vimāyapura, which is now located in north-east Thailand (Maxwell, 2007, pp. 84-5).

Finot (1925, pp. 421-2) used another Sanskrit word, 'dharmasālā,' to interpret these structures since he considered the highways as pilgrimage routes and the buildings beside them as religious hostels. He noted that the reason for considering them *dharmasālās* is the presence of Lokeśvara Bodhisattva, which offers protection against dangers such as brigands, elephants, snakes, and wild beasts. Although the term 'dharmasālā' doesn't appear in the Preah Khan inscription, it has since become widely used to refer to these rest houses. In a first-hand account of Khmer civilization written by a Chinese envoy who resided in Angkor for a year between 1296-1297, the Khmer referred to these resting places as *'sen-mu'* (Khmer, *samnak)* (Chou, 1992, p. 65).

In the practice of performing generosity, providing a free *sālā-samnak* to travelers and passersby is an expression of collective hospitality and generosity. More importantly, this is a grassroots initiative by the people to give back to the community. In some cases, *sālā-samnak* is interchangeably called *sālā-bun* (a merit-making hall) for a slightly additional function and purpose.

The main purpose of *sālā-bun* (see Figure 3) is to offer a nearby location for the elderly members to conduct meritorious activities in their Buddhist communities. Apart from merit-making activities, *sālā-bun* serves as a community gathering place for traditional festivals, especially for the 'village festival' that takes place after the harvest. Although *sālā-bun* is primarily a Buddhist ceremonial place, it also offers a free resting place for travelers and passersby. Due to this, *sālā-bun* is sometimes referred to as *sālā-chortean,* which means the hall where six items are donated. The *sālā-chortean* contains six items that travelers and passerby can use for free: a sleeping place, a water jar, a toilet, a mosquito net with mattress, pillows, and traditional medicine.

In most cases, *sālā-buns* are built for those who live far from Buddhist temples to make it easier for them to visit and perform meritorious deeds in their community. In the community, whenever there is a Buddhist festival, the monks in the nearby pagodas are always invited to participate. Building *sālā-bun* in the communities has made it easier for the elderly, most of whom find it difficult to travel to the temples.

We interviewed Ian Oeun, 76, who donated his land to build a *sālā-bun* in Moung Russey District, Battambang Province, Cambodia. He explained that since the Buddhist temple was too far from where he lived, making it difficult for the elderly to perform traditional Buddhist ceremonies, he and the people in his community decided to build a *sālā-bun*. He explained that he was inspired to donate his land for the benefit of his community after listening to a Buddhist monk preaching about charitable acts; particularly the Jataka story of a man named Magha performing public services by constructing roads and rest houses for the public. Oeun emphasizes that even though he is the land donor for the *sālā-bun,* all community members financially contributed to its construction. Therefore, he states that this *sālā-bun* is not exclusively his property but belongs to the community. Community members have an equal right to manage and use it according to their needs.

Figure 3 *Sālā-bun in Wat Chork Community, Kakaoh Commune, Moung Ruessei District, Battambang Province, Cambodia (Source: Author)*

According to one of our interviewees, Venerable Nhory San, the abbot of Wat Chork Thom monastery in Moung Ruessei District, Battambang Province, Cambodia, the *sālā-bun* has played a significant role in serving the public interest in the Buddhist community. He explains that the *sālā-bun* has made it possible for the elderly to perform charitable activities without traveling long distances to the pagoda. He also noted that the role of the *sālā-bun* has changed significantly over time, with fewer travelers and passersby nowadays. However, it has become a place for offering alms and performing meritorious deeds following Buddhism.

In other communities, the *sālā-bun* serves not only as a place for Buddhist ceremonies but also as a means to reduce poverty. In our interview with Tung Da, a representative of the *sālā-bun* in the Chork Thom community in Moung Russey district, he told us that the *sālā-bun* in his community had established a fund to support the elderly, including paying for medical treatment and providing loans at a low-interest rate to its members. Most of the fund's income comes from renting community equipment at the lowest possible prices and partly from fundraising. All funds derived from equipment leasing and fundraising are managed directly by community members without interference from public or private institutions.

Discussion

The relationship between religion and society has long been a subject of profound interest and significance, as noted by scholars like Ongaro and Tantardini (2023a, 2023b). The influence of religion in the public realm has shaped societies, norms, and power structures throughout history. One particular religious tradition that has gathered significant attention is Buddhism. Its uniqueness as a world religion, as highlighted by Habermas (Habermas, 2019; Foshay, 2009; San, Drechsler, & Shakya, 2023), extends beyond the spiritual and philosophical aspects.

Buddhism refers to how one should lead their life, avoiding causing harm to oneself, those around them, and society at large. The fundamental principles of interconnectedness, compassion, moderation, and simplicity, believed to be the pathway towards a rightful and sustainable life, are incorporated into the public sphere and people's daily lives. Hence, this ethical approach also reflects in the ways the Buddhist community organizes, makes decisions and manages resources.

Informed by the case of Cambodia, this interaction between religion and society is manifested through the relationship between the *saṅgha* and the lay community in their daily practices. The *wat* and *sālā-samnak* serve as platforms to facilitate these interactions. The *saṅgha* as an institution and its symbiotic relationship with the laity, the *wat* as a communal space dedicated to spiritual activities, and the *sālā-samnak* as a community space for secular activities, are primarily purposed to serve the common good anchored in Buddhist ethics.

The three cases of the commons practices in the Cambodian Buddhist community demonstrate how Buddhist ethics, values, and belief systems play a significant role in driving our society which is working beyond the market-oriented economy. What makes these three cases unique is that they run their institutions both spiritually and secularly, based on the principles deeply rooted in Buddhist ethics. Motivated by the pursuit of individual and collective good, they are driven by the concept of making merit rather than self-interest.

As discussed earlier, the principles employed by the Buddhist community to govern their institutions often reflect elements of the commons, closely aligning with Ostrom's principles such as monitoring, sanctioning, shared rights, voting, consensus-based decision-making, and collective choice rules. These principles have been demonstrated as key factors within the Buddhist community, shaping their motivations for collective behavior and enabling them to govern their commons in an ethical and sustainable way.

From a different perspective, the aforementioned examples demonstrate how religion and spirituality manifest within the public realm as a commons, given that equity, inclusion, reciprocity and sharing are essential to their operation and sustenance. Furthermore, considering the ontological dimension of the commons as a mode of human existence that is mindful of individual, collective and planetary well-being, the emergence of Buddhist commons is a natural outcome. Put differently, Buddhist commons illustrate how Buddhism and the commons align, both from an organizational and ontological point of view, premised upon a mutual ethical framework and purpose.

The discussion on Buddhist commons is an opportunity to challenge the hegemony of the Western worldview; as it is boldly expressed through mainstream economics and the cultivation of a global monoculture promoting individualistic and antagonistic ways of living. Contrastingly, Buddhist commons demonstrates the dynamic character of the commons as a living system that can adapt in diverse contexts, not tied to a unilateral one-size-fits-all model. Moreover, shows an effective and timeless alternative of a socio-economic paradigm in practice.

Despite living in a society dominated by the market economy, Buddhist communities are still able to organize their institutions in a commons-based manner, framed by principles that transcend individualistic self-interest. These principles have served the needs of local people and kept their institutions functioning for centuries. Therefore, assuming that prerequisite of the social well-being is a growth-oriented economy driven by self-interest, profit-maximization and resource exploitation, in accordance with the global-Western trajectory, despite its deep consequences, is debatable.

On the contrary, the core idea of interconnectedness, interdependence, or "interbeing" (Hanh, 1991), as it pertains to both Buddhism and the commons, addresses the vulnerability of human existence and how much we depend on each other and nature. Rooted in the theory of *paṭiccasamuppāda*, i.e., "dependent origination" or "dependent co-arising", Buddhism teaches that all things arise in dependence upon other things; aligned with the principle of *karma*, which emphasizes that every action carries consequences. The idea of interbeing emphasizes that building our lives on ecosystem destruction and the suffering of others will only cause further suffering. But, also brings forward the potential of collective action and compassion towards all things for leading a healthy life, serving the common good and building sustainable futures.

Conclusions

In this chapter, we explored the relationship between Buddhism and the commons, informed by examples of the practices of the Buddhist *saṅgha* and lay community in Cambodia. The inquiry delved into the influence of Buddhism in public affairs, despite the common perception of it as an apolitical tradition (Weber, 1988). In this direction, we explored its influence on society, governance mechanisms, and resource management, looking beyond its spiritual and philosophical dimensions. Additionally, we underscored the ontological dimension of the commons, transcending the realms of politics, economics, and public policy.

Through the discussion on Buddhist commons, we emphasized the contextuality and adaptability of the commons as a social system of governance and co-management of resources. Furthermore, we pointed out that its ethical foundations are grounded in the ethos of interconnectedness, aiming for human and non-human well-being on individual, collective and planetary levels. In this sense, we posed that the commons is compatible with the fundamental Buddhist principles, and, hence, has naturally emerged within the Buddhist society.

In this chapter, we tried to demonstrate that Buddhism strongly emphasizes that everything is interconnected; nothing can stand alone. Therefore, it is very important to lead a life by avoiding causing harm to those around us, whether they are human beings, nature, or society at large. The compassion, moderation, and simplicity embedded in Buddhist ethics, believed to be the pathway towards a rightful and sustainable life, are incorporated into the public sphere and people's daily lives. This ethical approach reflects in the ways the Buddhist community organizes, makes decisions, and manages resources, which, as we argued earlier, aligns well with the principles of the commons.

Overall, Buddhist commons exemplify the conjunction between the spiritual and the secular in the public realm. Moreover, they provide a unique and practiced alternative of a socio-economic trajectory, challenging the ontological foundations of the dominant global-Western paradigm. Ultimately, Buddhist commons demonstrate the timeless potential of the commons to foster social and planetary harmony.

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Publication VI

Sklavounos, I., Kostoulas, P., Koutropoulos, G., **Kouvara, M.**, & Theocharis, C. (2020). Kalderimi X2, Tzoumerka, Epirus: Paving the way for a new generation of craftspeople. *Journal of Traditional Building Architecture and Urbanism*, *1*, 100−111. **ETIS 1.2.**

Kalderimi X2, Tzoumerka, Epirus: Paving the way for a new generation of craftspeople

Kalderimi X2, Tzoumerka, Epiro: Pavimentando el futuro para una nueva generación de artesanos

Kalderimi X2, Tzoumerka, Epiro: Abrindo caminho para uma nova geração de artesãos

Ionas Sklavounos, Panagiotis Kostoulas, Grigoris Koutropoulos, Mina Kouvara, Christophoros Theocharis

Boulouki is an interdisciplinary research and education collaborative effort, focused on studying traditional building techniques and materials. In Greek, *Boulouki* means "gaggle", a travelling group; a word evoking the tradition of itinerant companies of stone masons and craftsmen. The aim of our team is therefore to trace and document the living carriers of such traditional knowledge; to study and further disseminate it through workshops and real building projects which are organized in collaboration with local communities and their stakeholders[1]. So far, Boulouki has mostly worked in Epirus, a mountainous area of Greece that was once celebrated for its stone masons, and which is also a crossroads of various Balkan cultures.

Boulouki es un esfuerzo interdisciplinar y colaborativo de investigación y educación, centrado en el estudio de técnicas y materiales de construcción tradicional. En griego, *Boulouki* significa "cuadrilla", un grupo de viajeros; una palabra que evoca la tradición de las compañías itinerantes de canteros y artesanos. El objetivo de nuestro equipo es localizar y documentar a los portadores aún existentes de esos conocimientos tradicionales; y estudiarlos y difundirlos a través de talleres y proyectos de construcción que son organizados en colaboración con las comunidades locales y sus agentes[1]. Hasta ahora, Boulouki ha trabajado principalmente en el Epiro, una zona montañosa de Grecia que fue célebre por sus canteros y que, además, es una encrucijada de diversas culturas balcánicas.

Boulouki é um esforço interdisciplinar colaborativo de investigação e educação, centrado no estudo de técnicas e materiais de construção tradicionais. Em grego, *Boulouki* significa "quadrilha"; uma palavra que evoca a tradição das companhias itinerantes de pedreiros e artesãos. O objectivo da nossa equipa é, portanto, identificar e documentar os portadores vivos de tais conhecimentos tradicionais; estudá-los e divulgá-los ainda mais através de oficinas e projectos reais de construção, que são organizados em colaboração com as comunidades locais e as respectivas partes interessadas[1]. Até agora, Boulouki tem trabalhado principalmente no Epiro, uma zona montanhosa da Grécia que foi outrora reconhecida pelos seus pedreiros, e que é também uma zona de cruzamento de várias culturas balcânicas.

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< Part of the restored pathway | Parte del camino restaurado | Parte do caminho restaurado (Ionas Sklavounos, BLK)

> 1: Satellite view of the area 2: Map of the intervention area | 1: Vista aérea desde satélite 2: Plano del área de intervención | 1: Vista aérea desde satélite 2: Plano da área de intervenção (1: Google Maps 2: Grigoris Koutropoulos, BLK)

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1: Part of the restored dry-stone wall 2: Dry-stone wall rebuilt in order to allow the tree growth | 1: Parte del muro de piedra seca restaurado 2: Muro de piedra seca reconstruido para permitir el crecimiento de los árboles | 1: Parte do muro em pedra solta restaurado 2: Muro de pedra solta reconstruido para permitir o crescimento das árvores (1: George Dimitrakopoulos 2: Ionas Sklavounos, BLK)

This text provides an outline of a participatory project and an educational program which took place from September 9 to October 31 in 2019 in the settlement of Plaka, within the broader area of Tzoumerka (Epirus, Greece). One of the main goals of this event was to re-introduce Greek and Balkan craftspeople to the almost forgotten traditional technique of *kalderimi* – a type of cobbled pathway.

More specifically, this project consisted of reconstructing the cobbled pathway that leads to the historical Bridge of Plaka[2]. This pathway, which is 400 metres long, had suffered major alterations and severe damage during the past decades, and had been largely forgotten in favor of a recently constructed path stretching across the bank of Arachthos River. This project, named "Kalderimi X2", combined a two-month apprenticeship for a new generation of craftspeople from Greece and other Balkan countries with a two-week workshop on traditional stone masonry targeting a broader audience[3]. Overall, nine apprentices and twenty-five other participants from Greece, Albania, Serbia, Bosnia-Herzegovina, Bulgaria and Croatia worked side by side on the reconstruction of this pathway, under the guidance of three experienced masonry tutors. The program also included lectures given by renowned

Este texto ofrece una descripción de un proyecto participativo y un programa educativo que tuvo lugar del 9 de septiembre al 31 de octubre de 2019 en el poblado de Plaka, dentro del área más extensa de Tzoumerka (Epiro, Grecia). Uno de los principales objetivos de este evento era reintroducir a los artesanos griegos y balcánicos en la casi olvidada técnica del *kalderimi*, un tipo de camino empedrado.

Más específicamente, este proyecto consistió en reconstruir el camino empedrado que conduce al puente histórico de Plaka[2]. Este camino, de 400 metros de largo, había sufrido importantes alteraciones y graves daños durante las últimas décadas, y había en gran medida sido olvidado por la existencia de un camino de reciente construcción que se transcurre a lo largo de la orilla del río Arachthos. Este proyecto, llamado "Kalderimi X2", combinó un aprendizaje de dos meses para una nueva generación de artesanos griegos y de otros países balcánicos con un taller de dos semanas sobre cantería tradicional dirigido a un público más amplio[3]. En total, nueve aprendices y otros veinticinco participantes de Grecia, Albania, Serbia, Bosnia-Herzegovina, Bulgaria y Croacia trabajaron mano a mano en la reconstrucción de este sendero, bajo la dirección de tres experimentados maestros canteros. El programa también incluía

Este texto apresenta o resumo de um projecto participativo e um programa educativo que tiveram lugar de 9 de Setembro a 31 de Outubro de 2019 na povoação de Plaka, dentro da área mais vasta de Tzoumerka (Epiro, Grécia). Um dos principais objectivos deste evento foi voltar a apresentar aos artesãos gregos e balcânicos a técnica tradicional quase esquecida do *kalderimi* - um tipo de caminho de pedra

Mais especificamente, este projecto consistiu na reconstrução do caminho de pedra que conduz à histórica Ponte de Plaka[2]. Este caminho, com 400 metros de comprimento, tinha sofrido grandes alterações e danos acentuados durante as últimas décadas, e tinha sido amplamente esquecido a favor de um caminho recentemente construído que se estendia ao longo da margem do rio Arachthos. Este projecto, chamado de "Kalderimi X2", combinava um estágio de dois meses destinado a uma nova geração de artesãos da Grécia e de outros países dos Balcãs, com uma oficina de duas semanas sobre alvenaria tradicional dirigida a um público mais amplo[3]. No total, nove aprendizes e vinte e cinco outros participantes da Grécia, Albânia, Sérvia, Bósnia-Herzegovina, Bulgária e Croácia trabalharam lado a lado na reconstrução deste caminho, sob a orientação de três tutores com experiência em alvenaria.

professors and professionals, as well as hands-on seminars and demonstrations, from extracting stone to preparing and applying lime and mud mortars. Overall, the initiative attempted to address a knowledge gap that has already adversely affected the character of traditional settlements in the Epirus region and the historic sites of the Balkans in general.

It should be noted that the term *kalderimi* usually describes a specific type of cobbled pathway and at the same time a building technique in which stones are placed vertically on the ground without the use of mortars. Traditionally, the steep parts of a *kalderimi* are equipped with a series of slightly protruding stones called selvedges[4]. These lines of

conferencias impartidas por profesores y profesionales de reconocido prestigio, así como seminarios prácticos y demostraciones que abordaron diversos trabajos, desde la extracción de piedra a la preparación y la aplicación de morteros de cal y barro. En general, la iniciativa trataba de resolver un vacío de conocimiento que ya ha afectado negativamente al carácter tradicional de los asentamientos de la región de Epiro y de las zonas históricas de los Balcanes en general.

Cabe señalar que el término *kalderimi* generalmente describe un tipo específico de camino empedrado y, al mismo tiempo, una técnica de construcción en la que las piedras se colocan verticalmente en el suelo sin utilizar mortero. Tradi-

O programa incluiu também palestras dadas por professores e profissionais de renome, bem como seminários e demonstrações práticas, desde a extracção de pedra até à preparação e aplicação de argamassas de cal e lama. Em geral, com esta iniciativa tentou-se abordar uma lacuna de conhecimento que já afectou negativamente o carácter das povoações tradicionais na região do Epiro e dos locais históricos dos Balcãs em geral.

Deve-se notar que o termo *kalderimi* descreve geralmente um tipo específico de caminho de pedra e ao mesmo tempo uma técnica de construção em que as pedras são colocadas verticalmente no chão sem a utilização de argamassas. Tradicionalmente, as partes íngremes de

Demonstration of traditional stone extraction during the 12-day workshop | Demostración de extracción tradicional de piedra durante el taller de 12 días de duración | Demonstração da extração tradicional de pedra durante o atelier de 12 dias de duração (Athena Apostolou)


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1, 2 and 4: Making traditional mortars during the 12-day workshop 3: Participants working on the pathway | 1, 2 y 4: Fabricación de morteros tradicionales durante el taller de 12 días de duración 3: Participantes trabajando en el camino | 1, 2 e 4: Fabricação de argamassas tradicionais durante o atelier de 12 dias de duração 3: Participantes a trabalhar no caminho (1, 2, 4: Athena Apostolou 3: Pietro Radin, George Zoilis)

Carving an *arkas*, a type of traditional stone barrier | Tallado de *arkas*, un tipo de quitamiedos tradicional de piedra | Esculpido de *arkas*, um tipo de barreira protectora tradicional em pedra (Ionas Sklavounos, BLK)

stones are usually placed at intervals of approximately 1.40 metres, a length which corresponds to the step of draft animals, such as horses and mules. Selvedges are placed to facilitate walking in the difficult conditions of rain and hard frost, but they are also useful in terms of mechanical strength. Finally, a *kalderimi* often includes a watering channel, which guides rainwater to nearby fields or cisterns. For these reasons, *kalderimi* should be seen as a broad category with a wide spectrum of typological variations, changing from place to place, but still retaining a certain identity.

However, since the 1950s, this type of pathway has been progressively replaced by modern constructions which rely mainly on the use of concrete and paving slabs. As mentioned above, this also occurred in Plaka, where more than half of the traditional structure was ruined, or had at some point in the past been thoughtlessly repaired.

cionalmente, las partes empinadas de un *kalderimi* están provistas de una serie de piedras que sobresalen llamadas *úja*[4]. Estas líneas de piedra suelen colocarse a intervalos de aproximadamente 1,40 metros, una longitud que corresponde al paso de animales de tracción, como caballos y mulas. Los orillos se colocan para facilitar la marcha en condiciones difíciles, como lluvia y heladas, pero también son útiles para la tracción mecánica. Por último, un *kalderimi* a menudo incluye un canal de riego, que guía el agua de lluvia a los campos o cisternas cercanas. Por estas razones, el *kalderimi* debe considerarse una categoría con un extenso abanico de variaciones tipológicas, que cambia de un lugar a otro, pero conserva cierta identidad.

Sin embargo, desde la década de 1950, este tipo de sendero ha sido progresivamente reemplazado por construcciones modernas que se basan principalmente en el uso de hormigón y pavimentos enlosados. Como se mencionaba anteriormente, esto también ocurría en Plaka, donde más de la mitad de la estructura tradicional estaba en ruinas o en algún momento del pasado se había reparado de forma descuidada.

um *kalderimi* são equipadas com uma série de pedras ligeiramente salientes chamadas *úja*[4]. Estas linhas de pedra são normalmente colocadas a intervalos de aproximadamente 1,40 metros, um comprimento que corresponde ao passo dos animais de tracção tais como cavalos e mulas. As ourelas são colocadas para facilitar a marcha em condições difíceis de chuva e geada, mas também são úteis em termos de força mecânica. Finalmente, um *kalderimi* inclui frequentemente um canal de rega, que guia a água da chuva para campos próximos ou cisternas. Por estas razões, o *kalderimi* deve ser visto como uma categoria ampla com um amplo espectro de variações tipológicas, mudando de lugar para lugar, mantendo ainda assim uma certa identidade.

No entanto, desde os anos 50, este tipo de caminho tem sido progressivamente substituído por construções modernas que dependem principalmente da utilização de betão e pavimentos de lajedo. Tal como acima mencionado, isto também ocorreu em Plaka, onde mais de metade da estrutura tradicional foi arruinada, ou foi em algum momento no passado reparada de forma negligente.

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1: Laying the cornerstones of the pathway 2: Demonstration of traditional stone carving techniques by a senior stone mason, Giorgos Pappas | 1: Colocación de las piedras del camino 2: Enseñanza de las técnicas tradicionales de tallado en piedra por el maestro cantero Giorgos Pappas | 1: Colocação das pedras no caminho 2: Ensino das técnicas tradicionais de esculpir em pedra pelo mestre canteiro Giorgos Pappas (1, 2: Pietro Radin, George Zoilis)

While surveying the pathway, our team recorded the presence of two major types of *kalderimi*, which we later integrated into our reconstruction proposal. The first type is characterized by the use of rectangular and oviform slate stones, most of them collected from the nearby river. This structural type, where stones are 'built' in the ground and 'weaved' together, following a logic similar to dry-stone wall building, is indeed the predominant and most widespread type of *kalderimi* in the region of Epirus. The second typological variation we recorded was based on the use of irregular cuneiform limestone pieces (apparently collected from the surrounding agricultural fields), carefully stuck together. This second type, which can also be found in many settlements of Epirus, can be considered a more humble structure; a *kalderimi* made by common people rather than craftsmen.

After carefully considering their current condition, our team proceeded to restore the surviving parts of the old structure and to fully reconstruct its severely damaged or altered sections. These works also included repairing existing stone fences and terraces, as well as the

Al estudiar el camino, nuestro equipo registró la presencia de dos tipos principales de *kalderimi*, que más tarde integramos en nuestra propuesta de reconstrucción. El primer tipo se caracteriza por el uso de piedras de pizarra rectangulares y ovoideas, la mayoría de ellas recogidas en el río cercano. Este tipo estructural, donde las piedras se 'construyen' en el suelo y se 'entrelazan' siguiendo una lógica similar a la de la construcción de muros de piedra en seco es, de hecho, el tipo de *kalderimi* predominante y más extendido en la región de Epiro. La segunda variación tipológica que registramos se basaba en el uso de trozos cuneiformes de piedra caliza irregular (aparentemente recogida en los campos agrícolas circundantes), cuidadosamente pegados entre sí. Este segundo tipo, que también se puede encontrar en muchos asentamientos del Epiro, puede considerarse una estructura más humilde; un *kalderimi* hecho por gente común en lugar de por artesanos.

Después de considerar cuidadosamente su condición actual, nuestro equipo procedió a restaurar las partes existentes de la estructura antigua y reconstruir completamente las secciones severamente dañadas o alteradas. Estos trabajos también

Durante o levantamento topográfico do caminho, a nossa equipa registou a presença de dois tipos principais de *kalderimi*, que mais tarde integramos na nossa proposta de reconstrução. O primeiro tipo é caracterizado pelo uso de pedras de ardósia rectangulares e oviformes, a maioria das quais recolhidas do rio vizinho. Este tipo estrutural, em que as pedras são "construídas" no solo e "tecidas", seguindo uma lógica semelhante à da construção de paredes de pedra solta, é de facto o tipo predominante e mais difundido de *kalderimi* na região do Epiro. A segunda variação tipológica que registámos baseava-se na utilização de pedaços cuneiformes irregulares de calcário (aparentemente recolhidos dos campos agrícolas circundantes), cuidadosamente colados uns aos outros. Este segundo tipo, que também pode ser encontrado em muitas povoações do Epiro, pode ser considerado uma estrutura mais "humilde"; um *kalderimi* feito por pessoas comuns e não por artesãos.

Depois de considerar cuidadosamente a sua condição actual, a nossa equipa procedeu à restauração das partes sobreviventes da estrutura antiga e à reconstrução completa das suas secções seve-

construction of two entirely new dry-stone retaining walls.

It is also worth noting that the steep part of the pathway, where the dry-stone retaining walls were erected, was also equipped with *arkades*: vertical stones that are usually found in the sides of traditional stone bridges of the Balkan area, serving as guardrails. This element was introduced here to evoke the nearby Bridge of Plaka, where the pathway leads. Finally, another original element of this project was the integration of carved stones within the restored *kalderimi*. These stones were carved by the sculptor Theodoros Papagiannis, professor emeritus at the Athens School of Fine Arts and who was from the area of Tzoumerka, and represent traditional symbols of prosperity and good fortune.

incluyeron la reparación de las cercas y terrazas de piedra existentes, así como la construcción en piedra en seco de dos muros de contención completamente nuevos.

Cabe señalar también que la parte empinada del camino, donde se levantaron los muros de contención de piedra en seco, también fue equipada con arkades: piedras verticales que suelen encontrarse a los lados de los puentes tradicionales de piedra de la zona de los Balcanes, y que sirven de barandilla. Este elemento fue introducido aquí para evocar al cercano Puente de Plaka, hasta el que conduce el camino. Finalmente, otro elemento original de este proyecto fue la integración de piedras talladas en el kalderimi restaurado. Estas piedras fueron talladas por el escultor Theodoros

ramente danificadas ou alteradas. Estas obras incluíram também a reparação de cercas e terraços de pedra existentes, bem como a construção de dois muros de contenção de pedra solta inteiramente novos.

É importante referir que a parte íngreme do caminho, onde os muros de contenção de pedra seca foram erguidos, foi também equipada com *arkades*: pedras verticais que se encontram normalmente nos lados das pontes tradicionais de pedra da região dos Balcãs, servindo de barreira protectora. Este elemento foi introduzido aqui para evocar a ponte vizinha de Plaka, onde o caminho conduz. Finalmente, outro elemento original deste projecto foi a integração de pedras esculpidas no *kalderimi* restaurado. Estas pedras foram

Participants working on the pathway | Participantes trabajando | Assistente a trabalhar (Athena Apostolou)

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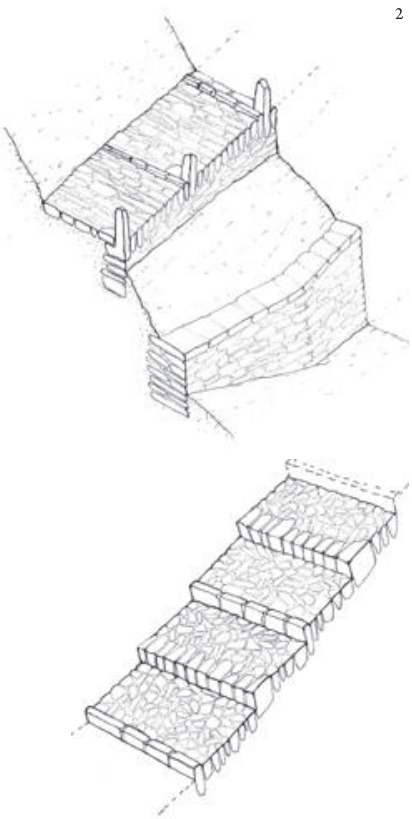

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1: Handmade timber scaffolding for the dry-stone retaining wall 2: Layout of the two different types of the cobbled pathway 3: Works in progress | 1: Andamio de madera hecho a mano para el muro de contención de piedra seca 2: Composición de los dos tipos diferentes de camino empedrado 3: Obras en curso | 1: Andaime em madeira feito a mão para o muro de contenção de pedra solta 2: Composição dos dois tipos diferentes de caminho empedrado 3: Obras em curso (1: Anna Lagaria 2: Grigoris Koutropoulos, BLK 3: Pietro Radin, George Zoilis)

Almost a year after completing "Kalderimi X2", we feel that this participatory restoration and educational project have opened up a number of different research directions for our group. The few technical and architectural observations made in this text describe just some of the critical aspects that emerged during the two-month apprenticeship and the twelve-day workshop. Indeed, the question of materials and techniques seems to be inextricably entwined with that of cultural values, while issues of authenticity and identity invite us to reflect on the processes through which traditional knowledge is (or may be) transferred across different regions, eras and cultures.

Papagiannis, profesor emérito de la Escuela de Bellas Artes de Atenas y originario de la zona de Tzoumerka, y representan símbolos tradicionales de prosperidad y buena fortuna.

Casi un año después de completar "Kalderimi X2", consideramos que este proyecto participativo de restauración y educación ha abierto una serie de líneas de investigación diferentes para nuestro grupo. Las escasas observaciones técnicas y arquitectónicas realizadas en este texto describen solamente algunos de los aspectos críticos que surgieron durante el aprendizaje de dos meses y el taller de doce días. En efecto, la cuestión de los materiales y técnicas parece estar estrechamente ligada con los valores culturales, mientras que las cuestiones de autenticidad e identidad nos invitan a reflexionar sobre los procesos mediante los cuales se transfieren (o pueden transferirse) los conocimientos tradicionales entre diferentes regiones, épocas y culturas.

esculpidas pelo escultor Theodoros Papagiannis, professor emérito da Escola de Belas Artes de Atenas, oriundo da zona de Tzoumerka, e representavam símbolos tradicionais de prosperidade e boa sorte.

Quase um ano após a conclusão do "Kalderimi X2", sentimos que este projecto de restauração participativa e educação abriu portas a uma série de direções de investigação diferentes para o nosso grupo. As poucas observações técnicas e arquitectónicas feitas neste texto descrevem apenas alguns dos aspectos críticos que surgiram durante o estágio de dois meses e a oficina de doze dias. De facto, a questão dos materiais e técnicas parece estar indissociavelmente interligada com a dos valores culturais, enquanto que questões de autenticidade e identidade nos convidam a reflectir sobre os processos através dos quais o conhecimento tradicional é (ou pode ser) transferido através de diferentes regiões, épocas e culturas.

[1] Since May 2018, Boulouki has operated as an Urban Non-Profit Company, based in Athens. For more information one may visit www.boulouki.org

[1] Desde mayo de 2018, Boulouki ha operado como una ONG, con sede en Atenas. Para más información, se puede visitar www.boulouki.org

[1] Desde Maio de 2018, Boulouki tem operado como uma Empresa Sem Fins Lucrativos Urbana, com sede em Atenas. Para mais informações, pode-se visitar www.boulouki.org

1: A human face carved by sculptor Theodoros Papagiannis and his assistant Fato Sulli 2: "A snake on the pathway" carved by sculptor Theodoros Papagiannis and his assistant Fato Sulli | 1: Un rostro humano tallado por el escultor Theodoros Papagiannis y su asistente Fato Sulli 2: "Una serpiente en el camino" tallada por el escultor Theodoros Papagiannis y su asistente Fato Sulli | 1: Um rosto humano esculpido pelo escultor Theodoros Papagiannis e o assistente Fato Sulli 2: "Uma serpente no caminho" esculpido pelo escultor Theodoros Pappagiannis e o assistente Fato Sulli (1, 2: Ionas Sklavounos, BLK)

[2] It is worth noting that the Bridge of Plaka, which was originally built in 1863 and collapsed in 2015, was at that moment also being restored. It was evident to us that the reconstruction of this significant landmark (the largest one-arched bridge of the Balkan area) could provide a new impetus for education and training in traditional craftsmanship in Greece.

[3] Kalderimi X2 was carried out in collaboration with the Municipalities of North and Central Tzoumerka, under the aegis of the Region of Epirus and the Greek Ministry of Culture and received funding from a number of nationally and internationally acknowledged entities, such as the Headley Trust (UK), the Technical Chamber of Greece (TCG), and Aegeas Urban-Non Profit Company.

[4] In Greek, the word for this line of stones is *ούγια* [úja] meaning indeed "an edge produced on woven fabric during manufacture that prevents it from unravelling".

[2] Cabe señalar que el Puente de Plaka, que fue originalmente construido en 1863 y se derrumbó en 2015, también estaba siendo restaurado en ese momento. Nos pareció evidente que la reconstrucción de este importante monumento (el mayor puente de un solo arco en la zona de los Balcanes) podría dar un nuevo impulso a la educación y la formación en la artesanía tradicional de Grecia.

[3] Kalderimi X2 se llevó a cabo en colaboración con los municipios de Tzoumerka del Norte y Central, bajo el amparo de la Región de Epiro y el Ministerio de Cultura de Grecia, y recibió financiación de varias entidades reconocidas nacional e internacionalmente, como el Headley Trust (UK), la Cámara Técnica de Grecia (TCG) y la entidad sin ánimo de lucro Aegeas.

[4] En griego, la palabra para esta línea de piedras es *ούγια* [úja] que significa, de hecho, "un borde producido en el tejido durante su fabricación, que impide que se deshaga".

[2] Vale a pena notar que a Ponte de Plaka, que foi originalmente construída em 1863 e desabou em 2015, estava também a ser restaurada nesse momento. Era evidente para nós que a reconstrução deste marco significativo (a maior ponte de um arco da região dos Balcãs) poderia dar um novo impulso à educação e formação em artesanato tradicional na Grécia.

[3] O projecto Kalderimi X2 foi realizado em colaboração com os Municípios de Tzoumerka Norte e Central, sob a tutela da Região do Epiro e do Ministério da Cultura Grego, e recebeu financiamento de várias entidades de referência a nível nacional e internacional, tais como o Headley Trust (Reino Unido), a Technical Chamber of Greece (TCG), e a Aegeas Urban-Non Profit Company.

[4] Em Grego, a palavra para esta fila de pedras é ούγια [úja] que significa de facto "uma borda feita em tecido durante o seu fabrico que o impede de se desfazer".

Ionas Sklavounos

He graduated in Architecture at the University of Patras and completed his post-graduate studies in Epistemology of Architecture at the National Technical University of Athens, where he also worked as Teaching Assistant in the courses of Architectural Design and Analysis and Study of Historical Settlements and Ensembles. He is a co-founder and co-administrator of "Boulouki". At the moment he is pursuing doctoral studies in the University of Antwerp within the "Communities of Tacit Knowledge: Architecture and its ways of Knowing" Innovative Training Network.

Se graduó en Arquitectura en la Universidad de Patras y completó sus estudios de posgrado en Epistemología de la Arquitectura en la Universidad Técnica Nacional de Atenas, donde además trabajó como Profesor Asistente en los cursos de Diseño Arquitectónico y Análisis y Estudio de Asentamientos y Conjuntos Históricos. Es cofundador y coadministrador de Boulouki. En este momento está cursando estudios doctorales en la University of Antwerp en el marco de la red de formación innovadora "Communities of Tacit Knowledge: Architecture and its ways of Knowing".

Licenciou-se em Arquitectura na Universidade de Patras e completou os seus estudos de pós-graduação em Epistemologia da Arquitectura na Universidade Técnica Nacional de Atenas, onde também trabalhou como Professor Auxiliar nos cursos de Desenho e Análise Arquitectónica e Estudo de Povoações e Conjuntos Históricos. É co-fundador e co-administrador de "Boulouki". Neste momento está a fazer um doutoramento na University of Antwerp no âmbito do "Communities of Tacit Knowledge: Architecture and its ways of Knowing" da Innovative Training Network.

Panos Kostoulas

He is an Architect, graduated in 2013 from University of Patras. Since then, he has worked as an architect, both as an employee and collaborator with several architectural firms in India and Greece and also as a part-time lecturer in Ooty McGan's School of Architecture in Tamil Nadu, India. He has participated in many workshops related to natural and traditional building techniques in India, Greece and Albania and has organised two workshops on earth architecture. He is currently completing a postgraduate program on Materials Science and Technology at the National Technical University of Athens, focusing on historic mortars. Panos is a co-founder and co-administrator of Boulouki.

Es Arquitecto, graduado en 2013 por la Universidad de Patras. Desde entonces, ha trabajado como arquitecto, como empleado y como colaborador de varios estudios de arquitectura en India y Grecia, y como profesor a tiempo parcial en la Ooty McGan's School of Architecture de Tamil Nadu, India. Ha participado en numerosos talleres relacionados con técnicas naturales y tradicionales de construcción en India, Grecia y Albania y ha organizado dos talleres de arquitectura con tierra. Actualmente está completando un posgrado en Ciencia de Materiales y Tecnología en la Universidad Técnica Nacional de Atenas, centrándose en los morteros históricos. Panos es cofundador y coadministrador de Boulouki.

É Arquitecto, licenciado em 2013 pela Universidade de Patras. Desde então, tem trabalhado como arquitecto, tanto como empregado e colaborador em várias empresas de arquitectura na Índia e Grécia, e também como docente em tempo parcial na Escola de Arquitectura Ooty McGan's em Tamil Nadu, Índia. Participou em muitas oficinas relacionadas com técnicas de construção natural e tradicional na Índia, Grécia e Albânia, e organizou duas oficinas sobre arquitectura de terra. Está actualmente a concluir a pós-graduação em Ciência e Tecnologia dos Materiais na Universidade Técnica Nacional de Atenas, sobre argamassas históricas. Panos é um dos co-fundadores e co-administrador de Boulouki.

Grigoris Koutropoulos

He is an Architect, graduated from the University of Patras. He has worked as a teaching assistant in the School of Architecture of the University of Patras and has participated in three research programs of the same institution, all of them pertaining to cultural heritage. He has participated in workshops about restoration of traditional buildings in Greece and Albania. During the last years, he has worked as a collaborator with two architectural firms which are focused on developing surveys about restoration of listed monuments in Greece, Cyprus, Turkey and Egypt. He is currently completing a post-graduate program on cultural management of monuments at the University of Athens. Grigoris is a co-founder of Boulouki.

Es Arquitecto, graduado por la Universidad de Patras. Ha trabajado como profesor asistente en la Escuela de Arquitectura de la Universidad de Patras y ha participado en tres programas de investigación de la misma institución, todos ellos relacionados con el patrimonio cultural. Ha participado en talleres sobre restauración y construcciones tradicionales en Grecia y Albania. Durante los últimos años, ha trabajado como colaborador con dos firmas de arquitectura que se centran en el

Boulouki team, the participants, the apprentices and their tutors on the pathway | El equipo de Boulouki, los participantes, los aprendices y sus tutores en el camino | Equipa de Boulouki, os participantes, os estagiários e os professores no caminho (Pietro Radin, George Zoilis)

desarrollo de estudios sobre la restauración de monumentos protegidos de Grecia, Chipre, Turquía y Egipto. Actualmente está completando un posgrado en gestión cultural de monumentos en la Universidad de Atenas. Grigoris es cofundador de Boulouki.

É Arquitecto, licenciado pela Universidade de Patras. Trabalhou como professor auxiliar na Escola de Arquitectura da Universidade de Patras e participou em três programas de investigação da mesma instituição, todos eles referentes ao património cultural. Participou em oficinas sobre restauração de edifícios tradicionais na Grécia e Albânia. Durante os últimos anos, tem vindo a trabalhar como colaborador em duas empresas de arquitectura que estão focadas no desenvolvimento de estudos sobre o restauro de monumentos classificados na Grécia, Chipre, Turquia e Egipto. Está actualmente a concluir uma pós-graduação em gestão cultural de monumentos na Universidade de Atenas. Grigoris é um dos co-fundadores de Boulouki.

Christoforos Theocharis

He is a Civil Engineer (DUTH) and he has been actively involved in the field of the built environment for more than ten years. Parallel to his job in an engineering office in Vienna, he finished his master's degree at TU Vienna with a major on Building Science and Technology. During his stay in Austria, as part of Bauklimatik GmbH, he has planned and supervised the construction of several small and middle-range buildings in Vienna and its surroundings. Since 2017 he has been pursuing a PhD degree at TU Vienna on "Vernacular architecture of the Epirus region in Greece". He has also participated in several workshops on vernacular architecture and traditional building techniques in Germany, Austria, Albania and Greece. Christoforos is a co-founder of Boulouki.

Es Ingeniero Civil (DUTH) y ha participado activamente en el sector de la construcción durante más de diez años. Paralelamente a su trabajo en una oficina de ingeniería en Viena, finalizó su master en la TU Vienna con una especialización en Ciencia y Tecnología de la Construcción. Durante su estancia en Austria, como parte de Bauklimatik GmbH, ha proyectado y supervisado la construcción de algunos edificios pequeños y medianos en Viena y sus alrededores. Desde 2017 está haciendo un doctorado en la TU Vienna sobre la "Arquitectura vernácula en la región del Epiro en Grecia". Además ha participado en varios talleres sobre arquitectura vernácula y técnicas de construcción tradicional en Alemania, Austria y Grecia. Christoforos es cofundador de Boulouki.

É Engenheiro Civil (DUTH) e tem estado activamente envolvido na área do ambiente construído há mais de dez anos. Paralelamente ao seu trabalho num escritório de engenharia em Viena, terminou o seu mestrado na TU Vienna com uma especialização em Ciência e Tecnologia da Construção. Durante a sua estadia na Áustria, como parte da Bauklimatik GmbH, planeou e supervisionou a construção de vários edifícios de pequena e média dimensão em Viena e arredores. Desde 2017, tem vindo a fazer um doutoramento na Universidade Técnica de Viena sobre "Arquitectura Vernacular da região do Epiro na Grécia". Participou também em várias oficinas sobre arquitectura vernacular e técnicas tradicionais de construção na Alemanha, Áustria, Albânia e Grécia. Christoforos é um dos co-fundadores de Boulouki.

Mina Kouvara

She is a professional architect and maker/artist by nature, and holds a MSc related to the environment and development of mountainous and remote regions (Metsovion Interdisciplinary Research Center at the National Technical University of Athens). Her research and practice focuses on the fusion of workmanship, heritage and education in reference to the socio-economic realm. Landscape as substance (matter and spirit) and as a theoretical and institutional tool is fundamental to her methodological approach. Mina is a co-founder of Boulouki and a former core member (2018-2020).

Es arquitecta profesional y creadora/artista por naturaleza, y realizó un máster relacionado con el medioambiente y el desarrollo de regiones montañosas remotas (Metsovion Interdisciplinary Research Center en la Universidad Técnica Nacional de Atenas). Su investigación y su ejercicio profesional se centran en la combinación de la artesanía, el patrimonio y la educación en el ámbito socioeconómico. El paisaje, como sustancia (materia y espíritu) y como instrumento teórico e institucional, es fundamental en su enfoque metodológico. Mina es cofundadora de Boulouki y antiguo miembro de la junta directiva (2018-2020).

É arquitecta profissional e criadora/artista por natureza, e possui um mestrado sobre o ambiente e desenvolvimento de regiões montanhosas e remotas (Centro de Investigação Interdisciplinar Metsovion, na Universidade Técnica Nacional de Atenas). A sua investigação e prática centra-se na fusão de artesanato, património e educação em referência ao domínio sócio-económico. A paisagem como substância (matéria e espírito) e como instrumento teórico e institucional é fundamental para a sua abordagem metodológica. Mina é co-fundadora de Boulouki e foi um dos membros principais entre 2018 e 2020.

Curriculum vitae

Personal data

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Education

2021–2025	Tallinn University of Technology, PhD Technology Governance
2016–2019	National Technical University of Athens (NTUA), MSC Environment and Development of Mountain Regions
2004–2013	Technical University of Crete (TUC), Integrated MSC in Architecture

Language competence

Greek	Native Speaker
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Professional employment

2021–Present	Tallinn University of Technology, Junior Research Fellow
2018–2020	Boulouki NGO (GR), Co-founder, Researcher, Architect/Practitioner
2019–2020	Technical Dept. Levadia Municipality (GR), Architect
2015–2016/2017–2018	We Design (GR), Architectural Assistant
2014–2015	Benedict O'Looney Architects (UK), Architectural Assistant
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Elulookirjeldus

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Hariduskäik

2021–2025	Tallinna Tehnikaülikool, doktoriõpe tehnoloogia valitsemises
2016–2019	Ateena Riiklik Tehnikaülikool (NTUA), MSc mägipiirkondade keskkond ja areng
2004–2013	Kreeta Tehnikaülikool (TUC), integreeritud MSc arhitektuuris

Keelteoskus

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Teenistuskäik

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2018–2020	Boulouki MTÜ (GR), kaasasutaja, teadur, Arhitekt/Praktik
2019–2020	Levadia omavalitsuse tehnikaosakond (GR), Arhitekt
2015–2016/2017–2018	We Design (GR), Arhitekti assistent
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