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Place-based innovation for sustainable and resilient human systems

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Abstract
This paper critically examines fail-fast culture and its compatibility with fragile contexts. It argues that to address complex global challenges, a nuanced 'fail well' approach is required. Drawing on the Gothenburg innovation ecosystem—among others—the paper highlights the importance of fostering partnerships between industry, government, non-government organisations, and higher education institutions to prepare emerging innovators for uncertain futures. Cross-sector cases emphasise the need for place-based, collaborative innovation, highlighting that successful innovation is non-linear and emerges through dynamic social processes and contextual influence. It calls for a shift in education towards inclusive, bidirectional pedagogies that integrate sustainability principles and systems thinking across disciplines. The paper concludes by advocating for a shift towards regionally focused, inclusive innovation cultures that prioritise context and community well-being over pursuing only economic goals. This approach is crucial for ensuring safe and just futures in the face of mounting global challenges.

Keywords Place-based innovation, Adaptive leadership, Sustainability education, Resilience planning

The 'fail-fast' culture of Silicon Valley has cultivated a set of attitudes and approaches towards innovation and scale that is often incompatible with fragile contexts. To truly address the needs of people, place, and the planet, innovators must respond to context at a more granular level, emphasising failing well if we fail at all. This builds on the notion that addressing our most wicked problems demands robust education systems and context-specific, place-based approaches that are intensely collaborative and adaptive [1–4].

The innovation ecosystem within the Gothenburg area serves as an example of this approach. Here, the innovation is decentralised, developing progressively through interactions between stakeholders, with trust, good relationships, and common interests. Rather than a single controlling strategy, many strategic interests of public, private, and academic actors meet. The Lindholmen Science Park stands out in the region as a broker of these interests and a creator of consensus and commitment among actors. Through formal and informal contact with stakeholders, it takes on an operational role that drives the development of the ecosystem, formulating collaborative efforts and initiating projects with a mix of private and public funding [1].

However, the success of this multi-stakeholder model relies on interdisciplinary education to prepare innovators for such ways of working. Just as Paulo Freire and Victor Papanek argued, education should involve active, bidirectional learning between disciplines, backgrounds, and aspirations. Papanek went further, advocating for inclusive, participatory, and reciprocal learning between designers and diverse end-users to create solutions that address social needs [5]. By involving local stakeholders through participatory processes, the resulting social and

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technological innovations can become more sustainable, equitable, and impactful [6, 7].

Failing fast: a failing culture for fragile contexts

Borrowing from international development discourse, a 'fragile context' describes a chronic breakdown of governance, security and capacity to support social, economic and ecological functions [8]. While for many innovators, these symptoms may feel unrelatable, the introduction of resilience planning to innovation practice demonstrates their increasing relevance [9]. This relatively new shift in systems innovation theory is the basis of the engineering philosophy of 'graceful failure', which considers failure inevitable and, therefore, a feature to be planned for [9, 10].

Meanwhile, the concept of fail-fast has evolved in industrial innovation culture as a doctrine that embraces risk-taking and accepts failure within cycles of rapid iteration in the pursuit of profit, often disinterested in social and environmental costs [11–13]. In direct contrast, graceful failure aims to mitigate risk extremes by emphasising learning, inclusive and collaborative processes and an intent to prioritise the long-term well-being of projects, stakeholder communities and ecosystems [1, 3, 13].

Some failures have become popular curiosities due to the velocity of their decline despite robust funding [14]. Amid strong investor interest in rapid-delivery grocery services during the lockdown triggered by the COVID-19 pandemic, Australia's MilkRun is a prominent example. After attracting an estimated AUD 88 m in 2021 [15], the company collapsed after just 18 months of operation and was acquired by an incumbent it aimed to disrupt [16]. Despite the significant number of astoundingly costly failures, this approach to scaling innovation has become the preference of fail-fast devotees [14, 17].

In targeting high-density, affluent urban areas during lockdowns, MilkRun aimed to deliver groceries within 10 min. However, as it sought to expand to more suburban areas post-pandemic, it encountered several obstacles, including higher operational costs due to greater delivery distances, increased competition from incumbents delivering from their existing store networks and rising rents for its distribution centres [15].

This highlights how success is contingent upon how innovation relates to specific spatial, economic, and social contexts. MilkRun was well-suited to its initial context—urban lockdown—but was not resilient to change.

While followers of the fail-fast doctrine might prefer MilkRun's rapid demise to slow failure, they might have missed the opportunity to fail gracefully by testing risky assumptions on a smaller scale or growing more responsibility before forcing the cost of catastrophic failure on stakeholders [10, 15].

Recognising complexity through adaptive leadership

More complex and conscious forms of innovation require new leadership that shows genuine awareness of the complexity of the operating system itself [18]. Many of our leadership systems have failed to fully acknowledge emerging paradigms of work, and the shift in decision-making required to become more adaptive in the transitions toward knowledge-led economies [18, 19].

Adaptive leadership describes the emergent change behaviours that arise from the interactions and interdependencies within complex adaptive systems that many traditional leadership styles struggle with. Influenced by complexity theory, adaptive leadership looks to capture novelty, creativity and learning that emerges from the spaces between agents, by engaging them in a dynamic and responsive approach to the informal processes that exist between more bureaucratic structures. Importantly, adaptive leadership looks to guide change through the engagement of stakeholders rather than attempting to control it [20, 21].

This failure to adapt to complexity has underpinned the crowding in of technology solutions to manage extraction within increasingly limited planetary boundaries, as such extraction creates numerous bidirectional social, environmental, economic, and cultural conditions that are complex in nature [22, 23]. Such digital technologies and data systems are frequently developed to simplify complexity or influence behaviour to enhance efficiency and productivity [23, 24]. However, their reliance on human governance introduces the risk of ineffectiveness or potential harm.

This, therefore, becomes a leadership challenge, as illustrated by an attempt to implement blockchain-based supply chain management by the Australian-based start-up Two Hands. Blockchain became popular as a tool to improve traceability for its ability to foster collaboration and immutable data storage [25]. Two Hands trialled this technology to encourage sustainable consumer behaviour at and beyond the point of purchase. The organisation found initial success with its system within the Chinese market, characterised by a sociocultural sensitivity to food fraud and a reliance on industrialised supply chains, particularly amongst high-value foods [26–29].

However, when applying the technology to the Australian context with the aim of addressing the fragility of industrialised supply chains, the application encountered friction. This friction resulted from a market that was characterised by incumbent powers striving to maintain their competitive edge through a confidential trading environment at odds with the objectives of the blockchain-based system [25].

This highlights the need for an adaptive leadership approach that leverages network dynamics and fosters

an 'adaptive space' to navigate complex local contexts. Rather than disrupting incumbents, adaptive leaders could have engaged in enabling strategies to link up diverse stakeholders and cultivate the emergence of adaptive solutions aligned with local needs [21].

The need for place-based innovation

Although the concept of growth is present in early economic theories, the study of change has not been a concern of the discipline in the way that culture change is in anthropology or social change is in sociology. An interest in technological change only emerged in the years following the Great Depression, along with a renewed interest in the role of mechanisation on employment. So "… it is to neo-classical economists that we owe the first interest in technological innovation, then called technological change, as the use of technological inventions in industrial processes" [30, p. 30].

However, these early conceptualisations of technological innovation as a linear process from invention to application separated knowledge creation from its use [30]. This obscures the dynamic social processes and contextual factors shaping complex innovation ecosystems like those in the Gothenburg area, which reveals that innovation is socially constructed through relationships and place-based assets, not just technical invention [1]. It demonstrates that innovation is shaped by local interests and challenges and a 'creative recombination' of existing assets, often with deep connections to cultural context and place [1, 31].

This suggests innovation unfolds through ongoing knowledge exchange and collective learning among diverse actors [3, 31], as Freire and Papanek also advocated. However, outcomes also depend on the alignment between technologies, infrastructure, regulations, user practices, and cultural meanings, among other elements [31, 32], demonstrating that innovation requires extensive collaboration and continuous adaptation to emerging conditions [3, 4, 31].

In contrast, MilkRun presented an example of innovation practised in a vacuum, absent of these qualities, resulting in outcomes at odds with common interests. Meanwhile, the Lindholmen Science Park embeds innovation within communities situated in place, fostering multi-actor stakeholder networks that ground solutions in local contexts and needs. This type of place-based innovation ecosystem integrating research, technological capabilities, governance frameworks, infrastructure, and civil society represents a compelling opportunity to facilitate interactive learning and coordinate sustainably oriented solutions tailored to regional needs [1, 3, 33].

Responding to regional needs requires innovators to move beyond universal solutions that risk failure or backlash when imported into different contexts [2–4, 33]. This is demonstrated in a study of wind energy projects across England, the Netherlands, and North Rhine-Westphalia. Stakeholders in one region held different views on community involvement and landscape from those in other regions, suggesting a need for localised engagement strategies adapted to community histories and landscape attachments [34].

The research identified a number of strategies with the 'independent developers' discourse—emphasising local participation and sensitivity to landscape impacts, most prominent in North Rhine-Westphalia—coinciding with successful wind power deployment. In contrast, the 'unconditional support' and 'contested wind' discourses, characterised by technocratic attitudes and local opposition, respectively, were strongest in England, where wind energy faced greater challenges [34]. These findings underscore how innovations must resonate with situated community practices, values, and identities to gain traction [33, 34].

Engaging with community life-worlds—the subjective world of our everyday experiences that shapes how we make sense of and engage with others and our surroundings [35, 36]—is therefore essential for sustainable innovations to take root [31].

In the context of sustainable innovations, this means considering the unique social, cultural, and historical contexts that shape how communities interpret and adopt new practices or technologies [37]. Innovations that align with and build upon existing community life-worlds through bottom-up experimentation are more likely to be embraced and sustained over time [37, 38]. This requires a deep understanding of local knowledge, values, and practices, as well as the active participation of community members in the design and implementation of innovations [39]. By grounding innovations within the life-worlds of communities, bottom-up experimentation can foster a sense of ownership and empowerment, leading to more resilient and contextually appropriate solutions [37, 40].

Fostering inclusive place-based innovation ecosystems requires aligning efforts across governance levels, from local municipalities to regional bodies to national programs. No single entity possesses sufficient perspective and capabilities. While higher levels provide vital resources, local partners discern priorities and disseminate solutions [1, 3, 33]. The European Commission can develop sustainability standards and incentives while regional coordinators identify pressing issues and municipalities directly engage citizens. Although limited staff and budgets often impede municipal sustainability efforts, forging reciprocal relationships across jurisdictions enables the combination of complementary strengths to overcome these challenges [33].

Beyond the partnerships already described, links into academia are also essential [1–4, 31, 41]. Universities contribute research expertise and talent development, while companies provide technical skills and manufacturing, governments lend convening power and policy frameworks, and communities convey situated needs and disseminate innovations [1, 3, 31, 33, 41]. Multi-stakeholder collaborations allow participants to reconcile competing aims, pool capabilities, and navigate complexity. They also amplify local relevance while connecting to global networks [2, 31, 33, 41].

Education for sustainability through inclusive pedagogies

Education is foundational in cultivating the mindsets, skills and values needed to realise place-based, collaborative innovation [42, 43]. However, mainstream models often struggle to fully engage students and communities around sustainability [42, 43]. Schools must nurture new pedagogical approaches to make education more bidirectional and inclusive [42, 43]. Sustainability principles must be more effectively incorporated into curricula to improve student preparedness, which requires more support from teachers [42–44]. For instance, Finland's national curriculum emphasises sustainable development, yet teachers struggle to incorporate it effectively across subjects. Lappeenranta's cross-disciplinary 'Uniori' initiative shows potential for building students' ecosocial capabilities through integrated STEAM activities. However, differences in sustainability perceptions across genders and educational tracks indicate that more emphasis is needed on tailoring activities equitably [42].

Despite the increasing maturity of sustainability education, this provides an example of a problematic legacy of fragmented education systems that have isolated sustainability concepts to specialities and continue to apply the 'banking' concept of education, where teachers deposit knowledge into passive students that Paulo Freire argued against.

Instead, Freire advocated for problem-posing education involving dialogue between teachers and students. Freire states that in problem-posing education, "the teacher-of-the-students and the students-of-the-teacher cease to exist and a new term emerges: teacher-student with students-teachers" [45, p. 80]. In this bidirectional approach, where teachers and students learn from each other, education liberates through active reflection and cooperation, transforming reality through praxis.

Similarly, design scholar Victor Papanek argued that design education should involve inclusive, participatory, and reciprocal learning between designers and diverse end-users to create solutions that address social needs and transform society. He advocated for designers to work closely with local communities and end-users to understand their needs and perspectives. Papanek promoted experiential learning through participatory design processes that engage diverse stakeholders in co-creating and prototyping solutions tailored to their needs and contexts. He viewed design as a tool for social change and believed that design education should cultivate social and ethical responsibilities among students. Papanek's human-centred, socially conscious approach indicates the potential for design education methodologies to be applied more broadly across disciplines to foster collaborative innovation for sustainability [5].

Beyond content integration, pedagogies fostering systems thinking and participatory skills are critical [42, 43, 46]. Tackling socio-ecological challenges demands transcending entrenched disciplinary boundaries [42]. Project-based learning allows students to analyse complex issues using multiple perspectives [42, 43, 46]. For example, a course engaging social work, peace studies and business students in collaborative case studies developed competencies for addressing interconnected environmental, social, and economic problems [42]. Place-based education also provides meaningful hands-on experiences grounded in local contexts. Initiatives linking schools with communities enhance motivation, environmental awareness, and collective action [43].

Teacher education must equip educators with competencies for sustainability. Key areas include systems thinking, future envisioning, empathy, and criticality. Rather than simply transmitting knowledge, educators need to support learners in recognising unsustainable practices, imagining alternative possibilities, and enacting change. This facilitates transformative learning that bolsters agency for creating sustainable futures [43]. Sustainability education should foster critically reflective, engaged citizens rather than compliant workers [47]. Such an education system should create the potential to drive future industries that accept and design for complexity over simplicity.

Bidirectional, inclusive education models are vital for cultivating sustainability competencies and participation [5, 42, 43, 46, 47]. Students need integrated curricula, multi-disciplinary projects, and context-specific learning opportunities to develop collaborative skills for societal and ecological resilience [5, 42, 43, 46]. Sustainability education must empower youth to address escalating climate disruptions and inequities. Rather than retrofitting curricula, schools must embrace their roles as catalysts for community resilience and regeneration [47].

Stewarding just transitions

Progress under extractive capitalism has long established 'sacrifice zones'—places of economically and politically marginalised communities treated as disposable in the pursuit of economic growth—abandoned for the

sake of professed collective advancement [48, 49]. The very existence of these zones reveals the unacceptable human costs of a fixation on growth bolstered by recklessly scaled innovation demonstrated by MilkRun. This approach systematically externalises social and ecological costs, amplifying instability and revealing the urgent need for a fundamental rethinking of our cultures of innovation and education [43, 47].

Alternative pathways centred on nurturing regional resilience and regeneration have been identified [3, 31, 44, 47], along with an appropriate scale for imagining future pathways, which is neither global nor national but dynamic localities composed of situated innovators. While the higher levels retain essential duties, local collaborations drive transitions [3, 31, 44].

Rather than maximising competitive advantage, innovators should cultivate mutualistic ecosystems directed towards collective thriving. Solutions embedding equity and care for ecological integrity become possible when diverse stakeholders coalesce around the well-being of future generations [31]. Innovations that challenge existing institutions and systems require partnerships between diverse stakeholders to reduce risk and enable the conditions for disruption to emerge and thrive, leading to broader systemic impacts [50].

This place-based approach combats the ennui of global technocracy with passion and creativity. Local heritage and meaningful narratives inspire collective action [3]. Students connect with sustainability when learning is situated in life-worlds [42, 43]. Universities should equip graduates for leadership with adaptability, systems thinking, and ethics for cooperative innovation [41, 49].

The future demands adaptable leaders capable of unifying stakeholders around inclusive visions for particular places, driving innovation and growth [3, 15, 31, 43], paired with education that provides arenas to rehearse collaborative skills and develop solidarity across differences [31, 41]. We believe this culture is essential for just futures that enable positive systemic change to address persistent societal challenges.

Conclusions

To counter the injustice designed into many human systems, we must become more conscious and collaborative, embracing the complexity and uniqueness of each context. Given the strong influence of contemporary capitalism, this requires a systemic re-design of our innovation ecosystems. While examples like those in the Gothenburg area exist, they are not the norm, and much more must be done to keep pace with the accelerated rate of global change.

Fostering sustainable and equitable innovation demands a shift from the fail-fast attitudes and rigid leadership of industrial innovation cultures. We must develop a more context-sensitive, place-based approach that cultivates inclusive, multi-stakeholder innovation ecosystems deeply embedded within local communities and responsive to their unique life-worlds. Navigating the complexities of these ecosystems through adaptive leadership and facilitating collaborative experimentation and learning is crucial.

This transformation begins with an integrated education system that embraces knowledge exchange, crossing traditional boundaries of learning in an applied manner to address challenges unique to each place. By nurturing the mindsets, skills, and values through education that embraces bidirectional, participatory pedagogies engaging students in real-world problem-solving, we can prepare emerging innovators for uncertain futures.

Abbreviations

AUD Australian Dollar
STEAM Science, technology, engineering, the arts, and mathematics

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Author contributions

BR conducted desktop research and synthesis of the literature on the scholarly approach to innovation. BR was a major contributor to writing the manuscript, particularly in relation to innovation theory. SR provided industry case studies and context to support the theory referenced within the manuscript. SR also contributed to the writing of case studies. Both authors read and approved the final manuscript.

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Publisher's Note

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