RESEARCH ARTICLE

The role of sustainability knowledge-action platforms in advancing multi-stakeholder engagement on sustainability*

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Abstract

Within the last decade, online sustainability knowledge-action platforms have proliferated. We surveyed 198 sustainability-oriented sites and conducted a review of 41 knowledge-action platforms, which we define as digital tools that advance sustainability through organized activities and knowledge dissemination. We analyzed platform structure and functionality through a systematic coding process based on key issues identified in three bodies of literature: (a) the emergence of digital platforms, (b) the localization of the sustainable development goals (SDGs), and (c) the importance of multi-level governance to sustainability action. While online collaborative tools offer an array of resources, our analysis indicates that they struggle to provide context-sensitivity and higher-level analysis of the trade-offs and synergies between sustainability actions. SDG localization adds another layer of complexity where multi-level governance, actor, and institutional priorities may generate tensions as well as opportunities for intra- and cross-sectoral alignment. On the basis of our analysis, we advocate for the development of integrative open-source and dynamic global online data management tools that would enable the monitoring of progress and facilitate peer-to-peer exchange of ideas and experience among local government, community, and business stakeholders. We argue that by showcasing and exemplifying local actions, an integrative platform that leverages existing content from multiple extant platforms through effective data interoperability can provide additional functionality and significantly empower local actors to accelerate local to global actions, while also complex system change.

Policy Significance Statement

The review of extant digital sustainability platforms is designed to inform best practices for policymakers and practitioners who work to promote the localization of the sustainable development goals and channel resources toward more effective and integrated sustainability solutions.

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*The online version of this article has been updated since original publication. A notice detailing the change has also been published.

1. Introduction

Amidst all the attention given to sustainability challenges at the global scale, such as climate change, biodiversity loss, and ecosystem destruction, the implementation of effective, innovative, and systemic solutions at the local scale can be neglected (Maddaloni and Sabini, 2022). Many local actors are ill-equipped to intervene in these "wicked problems" (cf. Rittel and Webber, 1973), lacking adequate knowledge and support, nevertheless progress toward "sustainability" at the local level is being made, particularly with the increasing use of the sustainable development goals (SDGs) to frame actions around thematic areas of sustainability dimensions.

While often context-specific, we assume that localized experiments and the good practices emerging from them could be valuable to stakeholders in other local contexts, and thus should be better documented, more widely shared, and more accessible for adaptation. Our focus in this article is on the "digital platforms" that are emerging to support these processes. We ask how a range of such platforms and their specific design features can be understood to be advancing local sustainability outcomes by facilitating "translocal" knowledge transfer and collaborative action among different stakeholders. That is, how digital infrastructure can affect locally rooted knowledge and its translation in different forms to varied geographic and spatial contexts to promote transformative change (see Loorbach et al., 2020).

1.1. Localizing sustainability: challenges and opportunities

Local sustainability initiatives have progressed since Agenda 21, the nonbinding action plan of the United Nations, was introduced at the Rio Earth Summit (UN, 1994). This inspired a wave of initiatives under the "Local Agenda 21" banner, including approaches developed within counter-cultural social movements such as eco-villages, Transition Towns, and intentional communities, some of which engage in cross-context dialogue and exchange. More recently, many local governments and stakeholder coalitions have made pledges and plans in response to a growing awareness of the local impacts of climate change (Damsø et al., 2016) through "climate emergency declarations." Other templates have emerged from prominent global networks of local actors, including ICLEI[1] and C40, who have taken steps toward facilitating the sharing of good practices and case studies among their members.[2]

The scope and specificity of "sustainability" in these local initiatives vary widely. Some define sustainability broadly, including social dimensions, while others focus strictly on climate change. Further, many climate action plans are geared exclusively toward mitigation while ignoring the adaptation aspects of climate change action, as detailed in the 2015 Paris Climate Agreement. In the urban context, discourses of sustainability have been further splintered into sets of competing logics, such as urban resilience, low-carbon transitions, smart urbanism, and urban securitization (Hodson and Marvin, 2017).

The SDGs, however, advocate for a more comprehensive and integrated approach and represent an ambitious pathway for collective global action on sustainability across a broad spectrum of interlocking ecological and social concerns. And yet, while the SDGs were created by national actors and envisioned as country-level goals, they are often less readily understood and applied at subnational scales. With little consensus on the parameters of localization, signatory nation states are at liberty to develop their own SDG monitoring efforts, and often at a loss as to how this is best achieved.

In addition, many agreed indicators of sustainability at the national scale have not received extensive commentary from local, multi-sector stakeholders, with little conceptualization from local-level priorities (Asokan et al., 2020). Moreover, many composite (weighted) or aggregated indicator sets can reflect undeclared normative assumptions (Asokan et al., 2020) unsuitable for use across diverse local contexts. Where action is taken to implement the SDGs within local systems, monitoring and reporting of progress has been uneven, and often altogether lacking, particularly in the Global South (Asokan et al., 2020)[#] where limited resources further constrain local leaders' capacity for action, but also in more "developed" countries such as the UK (UKSSD/LGA, 2020).

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[1] https://iclei.org/.
[2] https://www.c40.org/.

Meanwhile, with the localization issue left unresolved, local leaders will often act from an immediate need to find solutions, while not being linked to fully benefit from the actions and experiences of other actors in other local contexts or are unable to usefully document their own actions and experiences. As such, the need for more inclusively negotiated and locally adaptable frameworks to inform and structure sustainability action across a range of local contexts is urgent.

Scale and geography are fundamental factors in translating resources and knowledge into meaningful actions and outcomes. Greater recognition of the role of local contexts and places as laboratories for local sustainability innovations (Uyarra and Flanagan, 2010; Wanzenböck and Frenken, 2020)—should recognize that diversity across local contexts creates a challenge for reporting, but also holds largely unrealized potential trans-local knowledge exchange and mutual learning.

1.2. The role of digital technologies

The emergence of digital information and communication technologies, like social media (or "Web 2.0"), blockchain (or "Web 3.0"), machine learning (or "artificial intelligence"), and the internet of things (or "ubiquitous computing"), continues to transform and influence much of our societies, economies, and personal lives (Soto-Acosta, 2020). By enabling the recording, analysis, and sharing of knowledge in radically expanded ways, recently stabilized digital innovations appear to be already helping many local actors overcome the challenges of sustainability action as outlined above, by facilitating much-needed learning and collaboration.

Much of the recent attention paid to the impact, both positive and negative, of the "digital transition" has focused on the role of "platforms"—digital phenomena that, as we shall see later, evade easy definition. We posit that a recent proliferation of sustainability initiatives in the digital domain that refer to themselves as "platforms" and raises the question of how to assess the contributions said "platforms" make to transition processes, and—of special interest in our case—their ability to address the challenges of local transitions as described above. This is especially pertinent given that the resources required to build and maintain an effective "platform" appear to be considerable, that competition and cross-over between initiatives appear to be high, and that poorly designed or resourced platforms may not provide the support and information needed by local stakeholders.

The purpose of this article is to provide a state-of-the-art of the field, by identifying a sample of the "platforms" oriented toward advancing knowledge and action for local sustainability (herein referred to as: "knowledge-action platforms" [KAP]), describing and discussing their characteristics and, on that basis, mounting an assessment of how they contribute to local transition processes. We are also curious as to how the sociotechnical configuration of these platforms (e.g., their origins, design features, actual usage) mediates their potential for "depth" (impact), "width" (reach), and "length" (stability and duration) (Strasser et al., 2020), and their potential in the stabilization or maturation of the landscape of these platforms as a whole.

In the following section, we review three key issues in the scientific literature: (a) digital platforms and their application to sustainability (b) the localization of the SDGs, and (c) the importance of multi-level governance to sustainable action. We then describe our methodological approach, which entailed a descriptive matrix analysis of a sample of 41 "knowledge action platforms" (KAP). We conclude with a discussion of our results and the potential implications of such platforms for the localization of the SDGs and the role of platforms to promote the common good more generally.

2. Literature review

2.1. Digital platforms: a tool to advance sustainability?

2.1.1. The problem in defining "platforms"

The word "platform" has taken on myriad metaphorical meanings for centuries. Far from its very literal connotation as a flat surface, the dawning of the digital era has established and popularized the term's use

in reference to various phenomena enabled by information and communication technologies, often with very little else in common (Gillespie, 2010).

No widely accepted definition of "digital platforms" has been established yet. Many definitions, classifications, and taxonomies exist, but they often overlap and are used interchangeably, resulting in a lack of conceptual clarity (Zarra et al., 2019). In popular discourse, the term has been argued to have adopted a platitudinous quality, with some of its connotations alleged to reflect the vested interests of economic and political agents (Hansen and Mikkola, 2004; Lamarre and May, 2017). This section seeks to survey the various conceptualizations on offer and to identify and justify those with which we have chosen to frame this enquiry.

Blaschke et al. (2019) distinguish "digital platforms" based on their composition and characteristics, defining them as "technical core artifacts augmented by peripheral third-party derivatives." Reviewing 46 academic papers on digital platforms, they produced a bottom-up taxonomy, identifying four layered and modular architectural dimensions (Blaschke et al., 2019, p. 3): the technological infrastructure, the core technology (software and/or hardware), the ecosystem (which can consist of a private and/or federated network of actors), and the connective services offered. These services can exhibit a "design orientation—as is the case with platforms connecting one designer to many users, such as iOS, Android, Windows, or Linux"—or an "exchange orientation"—as is the case with platforms enabling users to have one-to-one or group interactions, such as Facebook, PayPal, Uber, and Airbnb and the various sustainability platforms we have assessed in this article. Codognone et al. (2016) suggest that the defining feature of platforms is their capacity to match different user groups and make transactions between them more efficient.

Building on the exchange-orientated definition offered above, Cicero (2016) adds another dimension to the concept which is of interest here. Cicero argues that as well as comprising a connective or aggregative tool or service, "platforms" should also be understood in terms of their accompanying *conventions*, which together with the platform tool, facilitate two-sided or multi-sided peer-to-peer (P2P) transactions, often between "peer-producers" and "peer-consumers" of a range of goods or services (Choudary, 2016; Cicero, 2016; Hagel, 2016; Cicero and Heikkilä, 2020). Although production and consumption need not strictly imply a marketplace where money changes hands, these goods and services, whether concrete or abstract, can equally be exchanged in the spirit of gifting or the anticipation of reciprocity (Benkler, 2006, p. 117), depending on the conventions in place. As defined by Bonina and colleagues, "Digital platforms share three basic characteristics: they are technologically mediated, enable interaction between user groups and allow those user groups to carry out defined tasks" (Bonina et al., 2021).

But the diversity of digital platforms currently in existence encompasses a broad spectrum of normative assumptions, economic logics, and strategic objectives—ranging from capitalistic to commons-oriented. The addition of conventions to the material or tangible conceptualizations offered elsewhere, therefore, allows Cicero and colleagues to see platforms not only as "a technical artifact," but as a "strategy to mobilize and help an ecosystem produce shared value and express its potential" (PDT, 2019). In this light, we can understand digital platforms as part of deliberate strategy to catalyze the latent synergies across dispersed pockets of knowledge and action for sustainability, to produce better informed and better coordinated outcomes.

By using the term KAP, we thus seek to distinguish a subset of the more generic uses of "*platform.*" Our proposed category stipulates an online environment that facilitates the exchange of *knowledge*, to inspire, inform, guide, record, catalog, or assess *action* toward sustainability goals. This term does not discriminate between different kinds of exchange: directed or undirected, commercial (i.e., payment for knowledge services), or commons-oriented (i.e., reciprocal and voluntary knowledge sharing). As such, the KAP is aligned to Blashke et al.'s (2019) "exchange-oriented" character, while also comprising Cicero's (2016) attention to particular conventions and strategies for catalyzing latent synergies through these exchanges, thus still allowing for diversity in the kind of knowledge being exchanged, the exact means or tools or fora through which it occurs, and how these are designed and governed.

2.1.2. *The promise and perils of using digital platforms to advance sustainability*

The first research papers on digital platforms and sustainability, which appeared in the mid-2000s, predicted a "platform revolution" (Parker et al., 2016). The literature now covers digital platforms with a range of approaches and foci: from smart cities, the sharing economy, and platform cooperatives, to distributed energy sharing, and decentralized data storage and exchange. To date, however, there is a very limited exploration of how innovations in platform technology relate to sustainability challenges in the Global South (Onyango and Ondiek, 2021). The literature is also held back by difficulties with defining platforms, which affects their classification and the evaluation of their contribution to multi-level, localized efforts toward sustainability action.

Schut et al. (2018) suggest that digital platforms can enable sustainable innovations to scale out beyond the networks in which they were originally embedded, also helping to strengthen structural and longer-term engagement between stakeholder groups. They find that platforms can also assist in identifying areas for cross-pollination and enable people to understand their interdependencies across structural silos. Moreover, by bringing together different end-users and designers within a participatory exercise they can also provide opportunities for new knowledge creation within "a space for negotiation, conflict and dealing with power dynamics" (Perry et al., 2018; Schut et al., 2018, p. 98). Digital platforms can allow for unprecedented professional and social networking among the communities that are most vulnerable and disproportionately affected by the impacts of sustainability issues such as climate change.

Digital platforms can play a pivotal role in advancing sustainability by enabling new forms of sustainable consumption and fostering behavioral change among consumers. However, while offering promise for synergizing multi-stakeholder groups and interests, some markets within the landscape of digital platforms have caused "the death of distance," or an overlooking of local nuances, and their proliferation has had a disruptive impact (Zarra et al., 2019, p. 8, p. i). The marketplaces some of these platforms create are implicitly neoliberal, with the assumption that everyone should be tied into the global economy (Zarra et al., 2019) and with an inherent winner-takes-all logic, insofar as successful platforms stifle competition (World Bank, 2019 in Zarra et al., 2019). In addition, some may use the mutual and open connotations of "platformed" activity under false pretenses, presenting themselves as "collaborative" when they are not, or glossing over wider issues of gender, labor rights, and inclusion (Fuster Morell and Espelt, 2019).

Digital cooperatives, and notably Platform Cooperatives,[3] offer opportunities to cultivate the commons[4] and prefigure sustainable actions and fairer outcomes in what is more recently framed as Regenerative Platforms (Cicero, 2021). Yet while proliferating rapidly, many promising Platform Cooperatives have been built and soon petered out, ending up in the "graveyard" of failed digital experiments (Spitzberg, 2021). A certain stigma is attached to admitting failure, which may hamper the analysis of positive and negative lessons learnt. Schut et al. (2018) note that they received no entries in the "learning from failure" category when identifying their case studies.

Insufficient research exists on digital platforms' economic, social, and environmental impacts and their scope to enhance sustainability outcomes (Fuster Morell and Espelt, 2019), especially given that many marketplaces do not undertake sufficient, let alone standardized, Environment, Social and Governance (ESG) monitoring and evaluation (Zarra et al., 2019). Even those that incorporate the SDGs (discussed below in more detail) are not always able to effectively measure sustainability holistically, partly because the SDGs have an inherent focus on the impact of the economic system and pay less attention to data and governance dimensions (Fuster Morell and Espelt, 2019).

Local diversity is a major obstacle but also an opportunity. For example, Kawakubo and Murakami (2020, p. 1) report on experiments in Hokkaido and Kyushu, Japan, with building a "local SDG platform that enables stakeholders to register, search and share their efforts and best practices toward achieving the SDGs." The authors found that only 5% of global SDG indicators could be usefully applied at a local level

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[3] https://platform.coop/.

[4] Commoning is referred to here as "a practice of collaborating and sharing to meet every day needs and achieve well-being, of individuals, communities and lived-in environments," https://www.lowimpact.org/lowimpact-topic/commoning/.

and, even then, required a degree of modification, or "localization" before they could be applied. Meanwhile, the SDG Portal provided by the German Association of Cities and Bertelsmann Foundation,[5] for now, is more focused on measuring achievements relating to SDG indicators and making them comparable—to overcome issues of data interoperability—rather than facilitating peer-to-peer sharing of ideas within a solutions-focused space.

A recent report by the Sustainable Development Solutions Network's (SDSN) Thematic Research Network on Data and Statistics (TReNDS) echoes these views, noting that its vision is for "a user-centric system that actively supports public and private data users and encourages collaboration" (SDSN, 2019, p. 8). The UN Environment Programme (UNEP) in turn has proposed a "digital ecosystem framework" (Jensen and Campbell, 2019) which suggests that the global political economy of environmental data should support global public goods, inclusion, and accountability. Researchers have made similar recommendations, arguing that "modern communication technologies and social media platforms could play a major, even transformative role, in participatory decision-making" (Guha and Chakrabarti, 2019, p. 15). In a recent Brookings report, city leaders recommended "an online research platform with material designed specifically for city and local governments, and curated for applicability and usefulness, to make it as easy as possible to identify high-quality tools applicable to a city's specific needs" (Pipa, 2019, p. 7).

To address these issues, Zarra, et al. suggest that marketplaces—which, we note, play a part within the noncommercial or sharing economy sector—could encourage reporting on social and environmental commitments against known certification systems. This could lead to improvements in local government sustainability reporting since the clients and supply chain of local government could evaluate localized ESG commitments against a certification or benchmarking schema. These authors also suggest there should be a harmonized reporting system, enabling all platforms to align their organizational strengths and weaknesses toward sustainable outcomes with clear targets and an assessment of the progress toward them.

There is also a clear role for incentives to promote sustainable actions: if the sustainability credentials of those trading on a platform were more explicit, they could create a virtuous circle where consumers are rewarded to make greener choices (Zarra et al., 2019; Burnett, 2022).

2.2. Localization of the SDGs

The SDGs are an ambitious attempt to help advance sustainability at a global level through international cooperation. The SDG framework has generated an unprecedented degree of global consensus regarding what is required to move from the present state of unsustainable production and consumption to a future in balance with nature and delivering justice for all. The 17 goals and its associated 169 targets and 247 indicators seek to map the key elements necessary to transform global systems.[6] While alignment with the SDGs may be voluntary for the signatory nation states, associated implementation mechanisms may be perceived by federal states and local territories as an imposition. Local actors and change-makers did not set the 2030 agenda but bear much of the responsibility for realizing it.

Collaborative Climate Action suggests that localizing the SDGs is "a relatively new and unexplored concept" and Nationally Determined Contributions (NDCs[7]) are not yet well-related to local action. The implementation of the SDGs with and through subnational governments is nevertheless pivotal to achieving them. The Organization for Economic Co-operation and Development (OECD., 2020, p. 1) suggests that "at least 105 of the 169 SDGs targets will not be reached without proper engagement and coordination with local and regional governments." A recent policy brief on localizing NDCs in line with

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[5] https://sdg-portal.de/.
[6] See https://www.unsdsn.org/sdg-index-and-monitoring for the latest progress on progress toward the SDGs (though note nationally the data is often divorced from local context), a key issue raised in this article.
[7] NDCs are a key to translating the goals of the Paris Agreement into concrete action.

the 2030 agenda by Leyden and Deutschmer (2021) states that few countries have involved local authorities in their response to the SDGs.

By February 2021, some 24 local city governments had submitted voluntary local reports (VLRs)[8] to their national governments—carried out by sustainability officers and mayoral offices—though only 16 included indicators and data analysis. Only 55% of countries consulted local authorities in their response to the SDGs, and just 33% of countries have engaged in VLRs. An Institute for Global Environmental Strategies (IGES) report commented on 15 VLRs where governments struggle to translate their own, often quite advanced sustainability agenda into the language of the national reports (Ortiz-Moya et al., 2020). This may explain why only a few dozen among the millions of local jurisdictions globally have reported on the SDGs. Community ownership of the process is occurring in some places, such as the SDG Forum in Canterbury (England) and through a 4-step reviewing process in Los Angeles. However, there are few examples of VLRs being linked to national processes, suggesting a glaring need for improvements in national-local multi-level governance (CCC, 2021).

This lack of local reporting raises questions about the accountability measures that translate the SDGs from the global to the local and how subnational governments and their stakeholders may meaningfully shape a more localized response, increasingly termed as the localization of the SDGs. A 2021 EU report notes that the challenge lies in "providing a framework to inspire the selection of appropriate indicators, making reviews both comparable across Europe and targeting local situations and challenges" (Ciambra et al., 2021, p. 6). SDG localization seems to be almost impossible without setting specific local targets that make sense to local policymakers and actors.

Approaches to remedying localization issues differ, however, and tend to fall within two broad categories: (a) increased prescriptiveness and monitoring and (b) increased sensitivity to the uniqueness of local constraints, opportunities, priorities, and creativity. Many commentators oscillate between these opposite approaches. Various standardized local indicator sets have been proposed (Abraham, 2021).[9] The European Spatial Planning Observation Network (ESPON) prepared perhaps the most advanced SDG localization tool "to measure, monitor and benchmark the SDGs at the regional level [based on] Eurostat's SDGs reference indicator framework, which is used to monitor progress toward the SDGs in the EU context and particularly at the national level" (ESPON, 2020, p. 7).[10]

The problem remains that a centralized SDG implementation approach will struggle to compare and assess progress toward the SDGs, let alone a sustainability transformation more broadly defined. An alternative, decentralized, diversified, and bottom-up process of data aggregation may be required to reveal what solutions local actors are developing and also to support peer exchange of such innovative ideas at the subnational level. That is, a digital solution that can convene interests at multiple levels of governance that also includes metrics and tools that can speak to a wide range of local issues and acknowledge the different priorities of place. A solution that can offer aggregation of the local-to-global contributions toward wider sustainability goals aligned to the SDGs and other locally defined issues is required, such as combining metrics to assess local planning policy implementation, sustainable business development, or community placemaking priorities alongside regional, national, or international considerations.

As a Brookings report notes, SDG implementation will be compromised if perceived as a compliance exercise—additional city-specific tools and approaches are required within a context of city-to-city dialogues or a platform to curate city-specific implementation experiences, which are currently lacking

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[8] Local implementation Plans, inspired by SDG voluntary national reviews (VNRs).

[9] However, it should be remembered that there exist several extant sustainability indices which to varying degrees measure social and environmental indicators, such as the Ecological Footprint and Environmental Sustainability Index (for a comparative analysis see Zinkernagel et al., 2018) which too are often divorced from the local level (Merritt and Stubbs, 2012).

[10] A pilot study was conducted in three locations, and local indicators were selected following the OECD "RACER" criteria (Relevant, Acceptable, Credible, Easy, and Robust).

(Pipa, 2019, p. 2). This insightful report was based directly on the feedback of local city leaders who met in Bellagio in 2019 to discuss SDG localization, and thus reflects local perspectives. The participants further suggested a small subset of indicators, a "data floor," that could be common to cities pursuing the SDGs but that allows for local experimentation and variation in indicator design and utility. As Pipa suggests, "[t]hey recognized a healthy tension between comparability across cities, which helps spur innovation and share lessons, and customization to their local realities" (Pipa, 2019, p. 3). The key to strengthening the localization of the SDGs and galvanizing the localization movement is to improve multi-level governance and create an enabling institutional environment nationally (CCC, 2021), especially in the context of post-pandemic reconstruction (UCLG, 2020).

Any such solution should be globally accessible to ensure that developing countries are not left behind. As Rahman et al. (2020) points out, Asian countries are experiencing challenges in disaggregated data and inclusive implementation at regional and subregional levels. While local actors could benefit from more centralized support, much of today's sustainability innovation is taking place independently at the local level, both in terms of problem identification and solutions. The question is: *What would such a global and fully inclusive bottom-up process of data aggregation and networking look like*?

A pragmatic compromise solution to localization dilemmas could be to measure what can be measured and compare what can be compared while avoiding bureaucratic monitoring and accounting overreach. This would allow local actors to develop a wide diversity of SDG solutions, in keeping with the fact that the SDGs are a transformation map and not the transformation territory. Innovative approaches to the SDGs should be encouraged, as Szetey et al. (2021, p. 2) suggest, to "cocreate pathways to their achievement" (Szetey et al., 2021, p. 2) with the best solutions disseminated widely and, where possible, scaled up. "Promoting innovation, leadership … [and] systems thinking" at the local level could be a better option than exerting centralized control over every detail of local policy (NITI Aayog & UN India, 2019, p. 31). Such empowered local leadership of the SDG effort is referred to by Lanshina et al. (2019, p. 219) as "deep localization" while others refer to "community-defined sustainable development goals (CDSDGs)" (Winans et al., 2021, p. 2).

Many local governments may lack the technical capacity to map their own sustainability transformation arenas or to formulate adequate policies—suggesting additional capacity building is required (Regions4, 2018). Any engagement must nevertheless remain reciprocal. As Caniglia et al. (2021, pp. 98–99) note, "in research, we too often try to direct processes of change but fail to cultivate the relationships and conditions that allow for change to unfold." New types of learning are required to promote social and technical innovation that can cultivate innovation, new processes, methods, and tools for effective multi-level governance.

2.3. Multi-level governance and sustainable action

The access local actors have to the practical knowledge of peers, as well as the scientific knowledge of academic experts, varies significantly. Multi-level governance and its influence on sectoral transitions is a key concern of sustainability scholars and practitioners (e.g., Loorbach et al., 2017). May and Marvin suggest platforms can "provide interstitial mechanisms for social learning across and with partners, bridging the local and the global. Context-sensitivity and iterative flexibility enable platforms to articulate between internationally shared priorities and distinct local practices" (p. 196). Additionally, "platforms" that are well-embedded into existing urban and global projects help foster collaborative and comparative learning (p. 195). For instance, the Mistra Urban Futures Centre developed Local Interaction Platforms in the cities of Gothenburg, Cape Town, and Manchester to bridge diverse forms of knowledge and expertise in the pursuit of sustainability (May and Marvin, 2017).

Such a knowledge and experience exchange can lead to developing and implementing challenge-oriented innovation policies to "help to avoid reinventing the wheel, and instead build on established experience and expertise, yet in a new narrative and policy context" (Wanzenböck and Frenken, 2020). By design, digital platforms offer "collective, creative and innovative ways of communicating which can

more effectively and meaningfully help the public engage with climate change actions" (Boykoff, 2019, p. 56), and thus move effectively toward the SDGs (Bonina et al., 2021). "In view of the short time frame of less than a decade before we reach the first major target date for the SDGs (2030) … the importance of integrating all knowledge communities in coordinated responses to sustainability challenges becomes an increasing priority" (Hartman, 2020).

While the value of sustainability-oriented digital platforms to facilitate the exchange of knowledge and resources between scholars and practitioners can help overcome barriers to sustainable development, they can also generate tensions and paradoxical effects, such as disagreements regarding the most desirable solutions and further polarization between stakeholder groups (Hellemans et al., 2022). It is most important to highlight that digital platforms can exacerbate inequalities and power imbalances between the Global South and the Global North, which have historical sociotechnological dominance. Multi-level sustainability actions require flexibility to allow users in the Global South to better shape the technological resources to fulfill local objectives and serve local needs and desires (Bonina et al., 2021).

United Cities and Local Government (UCLG) also highlight the necessity of intersectoral collaboration as a prerequisite for "systemic action" (see Tan et al., 2019) through "multi-stakeholder and multi-level partnerships, and in the implementation, monitoring, and evaluation of the SDGs" (UCLG, 2020, p. 120; 10). This process does not stop with inspiring local governments but extends to all sectors, as "many countries are yet to discover the full power of local partnerships (between subnational governments, enterprises, civil society, universities, philanthropies, and communities) in SDG delivery" (Revi, 2017, p. ix). Perry, et al. suggest that "addressing urban sustainability problems requires the capacity to integrate and manage a wide range of intersecting forms of global and local knowledge to develop appropriate policy responses, instruments, and interventions" (Perry et al., 2018, p. 190). Collaborative governance arrangements seeking to bridge messy inter-organizational relationships and goals with innovative engagement solutions can become rich sites for inductive learning. Being attentive to the enmeshing of space and identity, along a continuum of the neighborhood, the city and the global, should help us appreciate how local contexts affect sustainability action dynamics (Shami, 2003, p. 80, in May and Marvin, 2017).

Collaborative arrangements do not replace "traditional" governance but are complementary through the provision of "in between" and interdependent relational spaces (Perry et al., 2018, p. 195). As Hawken et al. (2020, p. ix) suggest, "fractured governance makes it hard for such innovation to be scaled up or spread across government or across the whole of a city at a metro level"—and indeed leads to silos with few incentives to share data, affecting accountability and performance which has "both a democratic and a managerial deficit […with] consequences for livability, productivity and equity." Effective collaboration requires coproductive "boundary spaces" for the knowledge and expertise of participants to be valued and respected, and for certain actor types not to be privileged over others. Resulting tensions may lead to increasingly formal arrangements to impose accountability on some actors, which may constrain the scope for more adaptive arrangements (Perry et al., 2018, p. 195).

Spatial context adaptation is also important for evaluating technical and social innovations. Not all innovations can be readily transplanted across contexts, emphasizing hybridity and inter-relationality instead of dualist debates about the "local" and the "global" (Perry et al., 2018, p. 191). A focus on local context should not be at the expense of the multi-scalar interactions in situ or within wider systems of production and exchange, however, nor should the "experimental turn" capitulate to using local experimentation only and ignore best practice models (Perry et al., 2018, p. 195). May and Marvin argue we should "not only understand, but also move beyond individual case studies and place particular urban responses within wider comparative frameworks that bring together questions about the content of the policy and social context of knowledge production" (May and Marvin, 2017).

In sum, these different literatures provide valuable insights as to the capacity of virtual sustainability action platforms to address some of the insidious problems with SDG localization and multi-level governance. In the following section, we detail our empirical approach, which begins with a study of existing digital platforms and proceeds to evaluate their strengths and limitations.

3. Methodology

3.1. Conceptual framework

As noted above, we found no standardized definition of "digital platforms" that could be operationalized in the delineation of our sample. Having assessed a range of definitions for their pertinence to the advancement of knowledge and action for sustainability, we determined that, for the purposes of this study, every prospective "platform" in our sample should exhibit an "exchange orientation" in its service layer, and therefore facilitate some type of peer-to-peer connectivity, whether it be capitalistic, commons-oriented, or both. Notably, the platforms differed on the degree of exchange, with some offering opportunities for active exchanges, for example, through robust discussion forums or exchange markets, and others offering opportunities for more passive exchanges, such as through user posts.

3.2. Data collection and analysis

Data collection occurred between March and June of 2021. First, a preliminary list of purported "platforms" focused on advancing sustainability and using English as their main language was generated based on the authors' previous knowledge and experiences. During the analytic process, described below, we added to this list via the snowball principle, which resulted in a sample of 198 platforms. We then shortlisted those that were both currently active or under development and that focused on local sustainability, as opposed to sustainability more generally. Then we applied the above criteria to ensure there was a stable definition of "platform" being operationalized throughout defined in a coding database, to produce our final sample of 41 "knowledge action platforms."

To analyze the platforms, we conducted a descriptive matrix analysis, which entailed the construction of a novel dataset in Microsoft Excel. The matrix method "aims to represent a logically consistent and structured approach to the analysis of qualitative data" and is particularly well-suited for cross-sectional research (Groenland, 2014, p. 10). A descriptive matrix is essentially "a set of numbers or terms arranged in rows and columns that within which, or within and from which, something originates, takes form, or develops" (Agnes, 2000, p. 239). The data entered into the cells reflects "paraphrased, synthesized, or quoted content, which is systematically cross-referenced to identify similarities, differences, and trends" (Averill, 2002, p. 856). Patterns in the raw data are then categorized according to how they "load" on different factors. Overall, a matrix analysis "attempts to optimize the chances to arrive at poignant, useful, and especially trustworthy outcomes," which, in application, can "enable the development of reliable and effective recommendations" to improve processes or outcomes (Groenland, 2014, p. 10). For these reasons, we found that a matrix approach aligned well with the purpose of our research, as outlined in Section 1.

To construct the matrix, we began with a list of 20 provisional codes, which were used on the preliminary list of platforms during round one of coding and were revised during subsequent rounds. The resultant list included 18 attribute codes that provided basic descriptive information about the platforms. The resultant list also included 35 descriptive codes which, as Turner (1994, p. 199) put it, constitute the "basic vocabulary" of data that form the "bread and butter" categories necessary for greater analytic work. According to Saldana (2016, p. 104), descriptive coding "leads primarily to a categorized inventory, tabular account, summary or index of the data's content." For this reason, it lends itself well to matrix analysis.

The coding process was undertaken by four members of our research team, and to ensure consistency and validity we checked for intercoder reliability by cross-coding the same platforms and comparing the results. The final results of our analysis are discussed below.

4. Results and analysis

Overall, we found that there is no globally or even regionally dominant one-stop provider of online services for local actors, which creates a contested space. Comparison between the numerous platforms vying for attention requires a systemic approach. For one, we needed to populate and then cross-reference

local–global actions facilitated by different platforms against the SDGs and other sustainability approaches. We also compared geographical reach, users, business models, and a range of design features. Below, we outline our results by category.

4.1. Geographic reach

Geography relates to the significance of translocal innovative capacities across geographic and linguistic boundaries. Over half of platforms (57%) defined their geographical scope as global, while those platforms focusing on a select range of countries and those working solely within a national context each represented less than a quarter (19%) of the sample. Despite a majority voicing the ambition to achieve global reach, only one-third (33%) of the sample explicitly targeted entities based in the Global South. Action for Sustainable Development (A4SD) is an example of a platform with translocal reach, particularly within the Global South. With over 3000 member organizations, 80% of which are in the Global South, A4SD (n.d.) provides tools to track and measure progress on SDG commitments, while also providing opportunities to collaborate with the UN through participation in regional and global forums. By participating in the UN High-Level Political Forum especially, local changemakers have a formal say in the review of global sustainable development policies.

4.2. Platforms founded by year

Prior to 2016, the number of platforms launched annually was low and variable, but thereafter a continuous and steady increase can be observed (see Figure 1). While this trend demonstrates the accelerating growth and popularity of the platform economy, in this and other sectors, this is resulting in a crowded and confusing online scene, as users have the option to engage with many and varied platforms. Fewer and more well-developed platforms would serve users better, but there are also risks associated with this monopolistic tendency, as is well known from other sectors, such as social media, where a few platforms have come to dominate. Whether or not such risks are restricted to commercial platforms remains an open question. At present, most sustainability platforms are noncommercial (though commercial sustainability reporting frameworks are proliferating, these are not defined in our purposes as knowledge action platforms).

4.3. Platform creator

Most platforms were created by civil society and NGOs (32%), such as, for example, B Lab, which is best known for certifying B corporations but also provides standards, tools, and programs for systemic
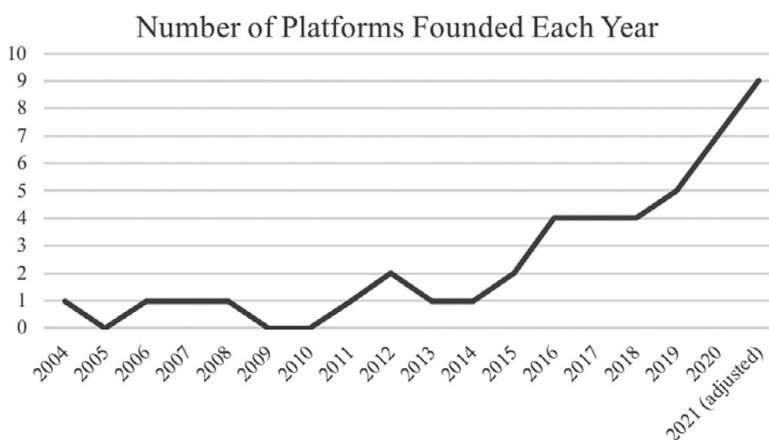

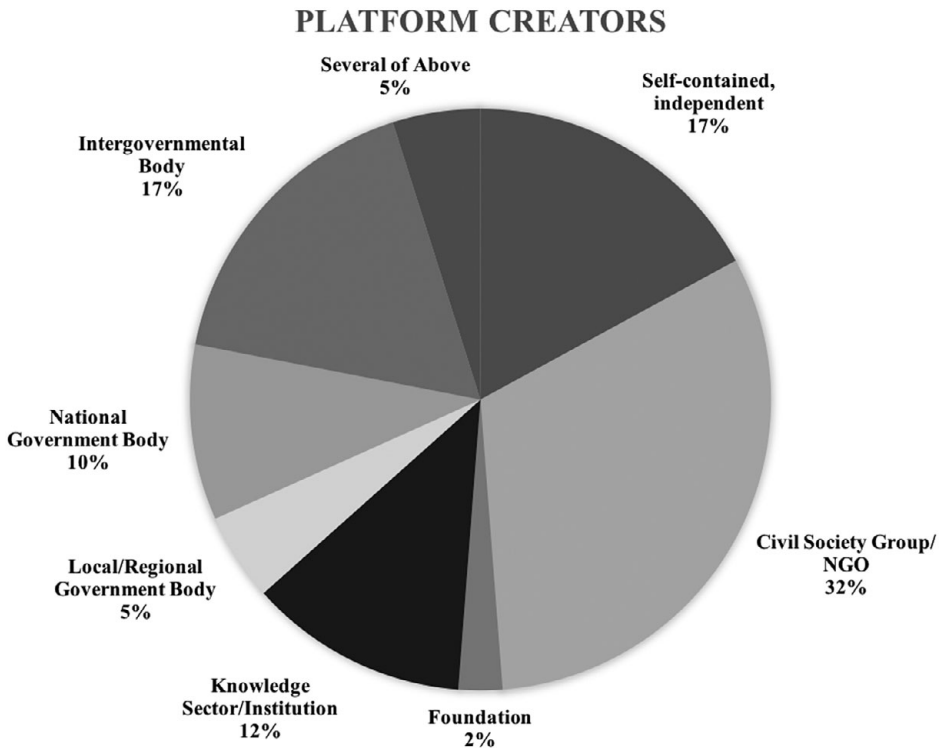**Figure 1.** *Platforms Founded by Year.*

PLATFORM CREATORS

Figure 2. *Platform Creators.*

change through a virtual network of nonprofit organizations (see Figure 2). This was followed by intergovernmental bodies (17%), such as UN agencies, and independent entities (17%), such as the previously mentioned A4SD. About a tenth of platforms were created by institutions within the knowledge sector (12%), such as the Germany-based Wuppertal Institute for Climate, Environment, and Energy, as well as by national government bodies (10%). An example of the latter is Smart City Dialogue, which is funded by the German Ministry of the Interior and provides cities, districts, and municipalities with digital space for sharing sustainability solutions. Although it was rare for a platform to have multiple creators (5%), it was common for them to receive financial support from multiple sources.

4.4. Platform financier

Of the platforms that identified funders (86%), nearly a third claimed multiple streams (31%). Governments were a principal funding source, with intergovernmental bodies financing nearly a quarter of all platforms (22%) and national bodies over a tenth (11%) (see Figure 3). Of intergovernmental funders, the EU was a primary funder, having supported major platforms such as Learning UCLG and the Green City Accord. Foundations too were major funders (14%). Only two platforms were funded by user or membership fees (6%, including the Urban Land Institute), which is not surprising given that few platforms charge for services. Although reliance on external funding implies greater access for end-users, it also raises concerns about politics and power. Consider, for example, how a multilateral development bank financing a digital platform may affect top-down accountability measures on sustainability actions. In addition, many platforms are underfunded and thus are lacking in capacity or are not kept updated as regularly as they could be.
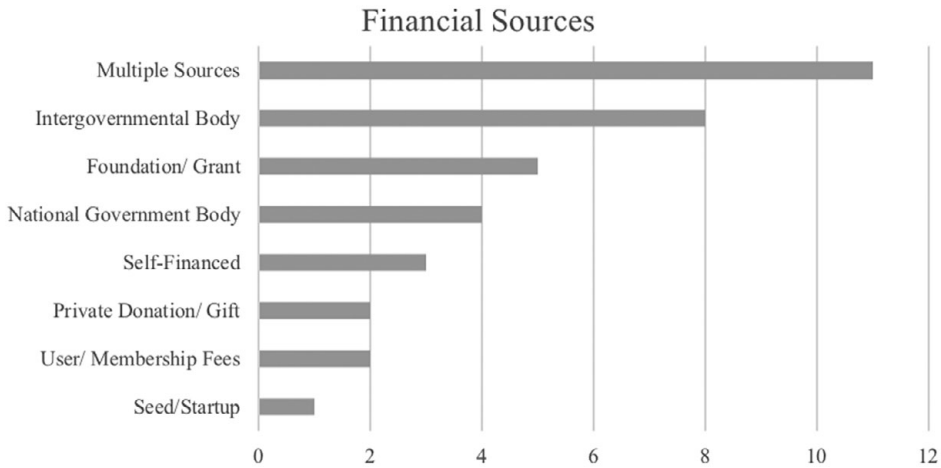
Financial Sources

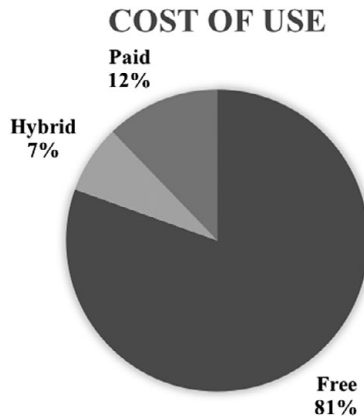**Figure 3.** *Platform Financier.*

COST OF USE

Figure 4. *Cost of Use.*

4.5. Cost of use

Almost all platforms were free to use (81%), with about a tenth having a paid-for feature or a combination of free and paid-for services (see Figure 4). The previously mentioned B Lab, for example, offers its assessment tool to businesses for free but requires a fee for the actual certification.

4.6. Conceptual frameworks

Many platforms either implicitly or explicitly identified the SDGs as the framework underlying their work (37%) (see Figure 5). The SDGs were a clear driver for the raison d'être of such platforms, and this may in part explain the rise in the number created since 2015, when the SDGs were announced. While nearly a quarter of platforms identified the need for a systems approach that included the triple bottom line of social, ecological, and economic dimensions (20%), the frameworks of system analysis differed. For example, the Laudato Si Action Platform draws on integral ecology, while several others, such as Project Drawdown, developed their own systems approach. ClimateView is a paid-for Swedish platform that helps cities manage their climate transitions underpinned by its "ClimateOS" technology that quantifies multiple impacts of climate (non) action and straddles city-based climate action with a cost–benefit and reporting tool. About a tenth framed their work in terms of "transitions" (12%), of which the majority
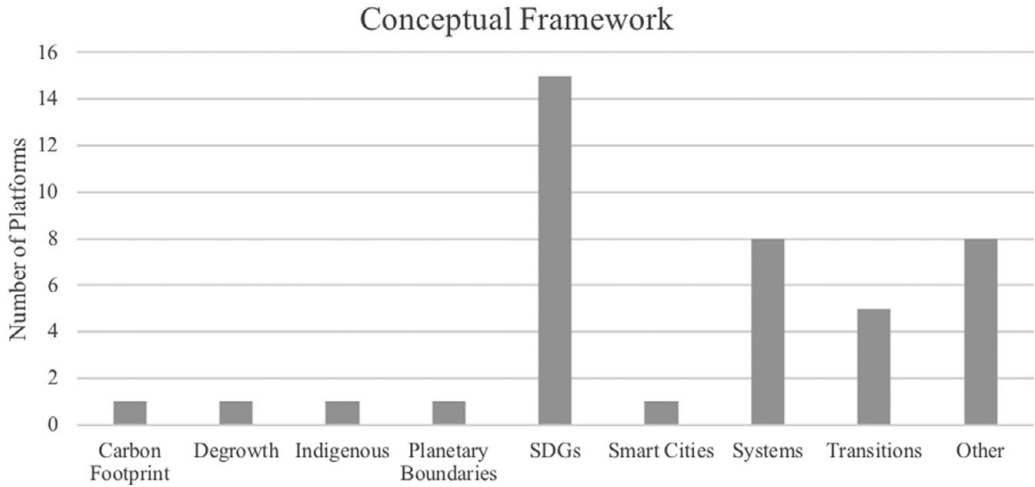
Figure 5. *Conceptual Frameworks.*

focused on energy (60%). Fewer platforms in our sample framed their work in terms of carbon footprints, degrowth, indigenous knowledge, planetary boundaries, or smart cities (2% each). Many did not specify an approach (20%).

4.7. SDGs addressed

All platforms implicitly or explicitly addressed three or more of the SDGs. Nearly all recognized the importance of partnerships (92%) and addressed cities (90%), which, given the specific selection of cases for the purpose of this research, is not at all surprising (see Figure 6). Climate (90%), energy (85%), and land use (85%) were also widely addressed, while issues relating to the ocean (41%) and gender (44%) were the least likely to be taken up by the platforms. Importantly, these codes only reflect whether the SDG was included or alluded to by the platform, rather than the degree to which an SDG was addressed.
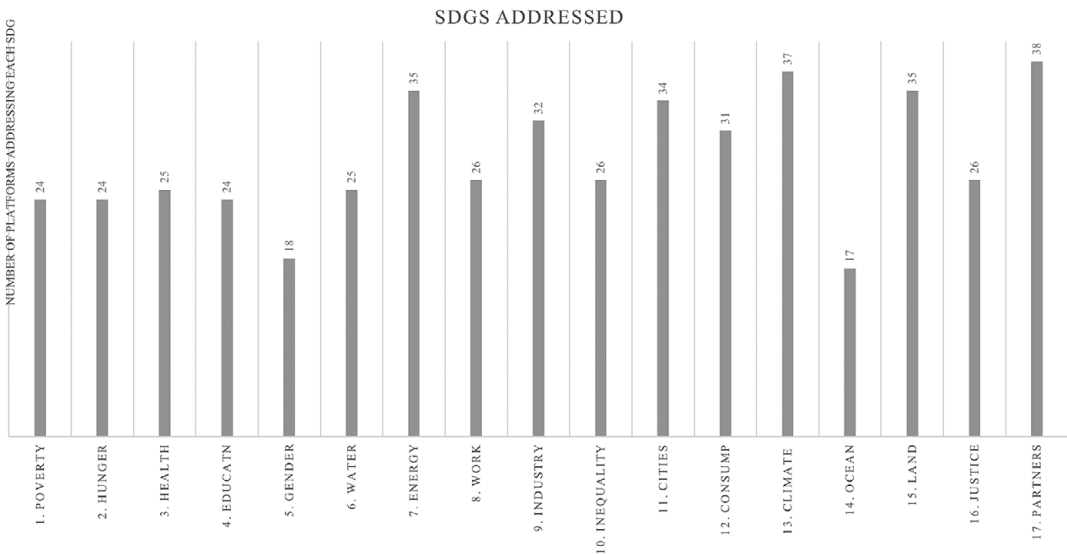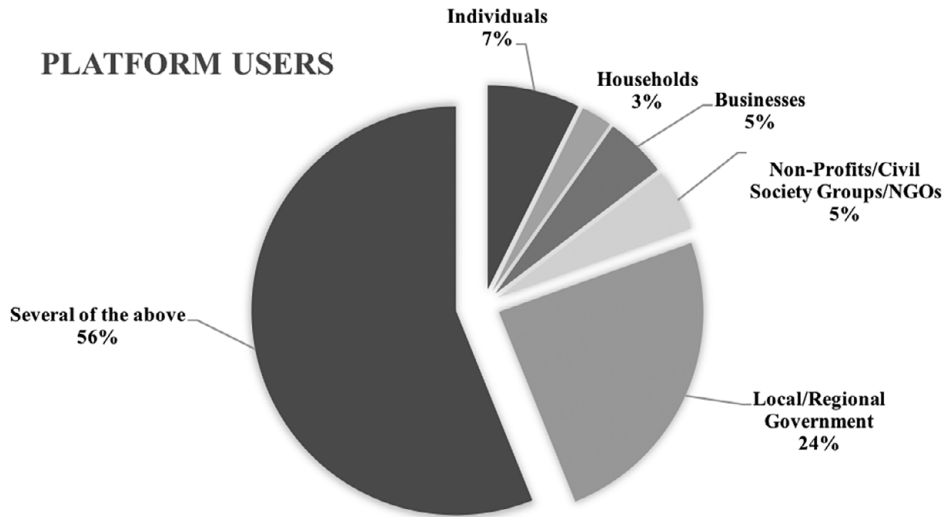

Figure 6. *SDG Addressed.*

PLATFORM USERS

Figure 7. Platform Users.

4.8. Platform users

Nearly a quarter of platforms targeted local or regional governments (24%), which is likely reflective of the focus of this research (see Figure 7). Far fewer platforms targeted individuals (7%), and only one platform, Sustainable Lifestyle Accelerator, which includes a carbon footprint calculator, targeted households (3%). Likewise, few platforms targeted only nonprofit organizations or civil society actors (5%). These included Acter, which is an entrepreneurial startup that provides collaborative management tools to advance sustainability solutions, and the Thriving Resilient Communities Collaboratory, which helps member organizations build resilient communities through networking, aid, and education. Like-wise, two platforms, the previously mentioned B Lab and the UN Global Compact Action Platform, targeted business (5%). Most platforms targeted multiple audiences (56%).

4.9. Size of user base

Of those platforms that reported the size of their user base (75%), most had less than 100 users (27%) or more than 10,000 (27%) (see Figure 8). Nearly half of platforms fell in between (46%), with many of them having greater than 100 but fewer than 5000 users (43%). Compared to major social media platforms, the user base is still miniscule, reflecting the fact that the field of sustainability platforms is still emerging and highly fragmented.

4.10. Platform governance

All but one platform reported their governance style (98%). Of those, the majority had closed systems of governance, which do not allow for any stakeholder participation in the management of the platform itself (65%) (see Figure 9). An equal number of platforms had either some formal mechanism to represent stakeholders and/or held administrators accountable (17%) or featured an open system of governance (17%). Both the previously mentioned A4SD and B Lab provided some mechanism for stakeholder participation. So too did Learning UCLG, which promotes decentralized cooperation for sustainable development. Global Ecovillage Network (GEN, n.d.), on the other hand, featured an open system of governance. Rooted in the regenerative movement, GEN is overseen by a board of trustees that includes two representatives from each region in which it is active, plus an active general assembly with nine representatives from each region. Additionally, GEN board decisions are informed by an advisory board, as well as a council of elders that represent the founders of the GEN movement.
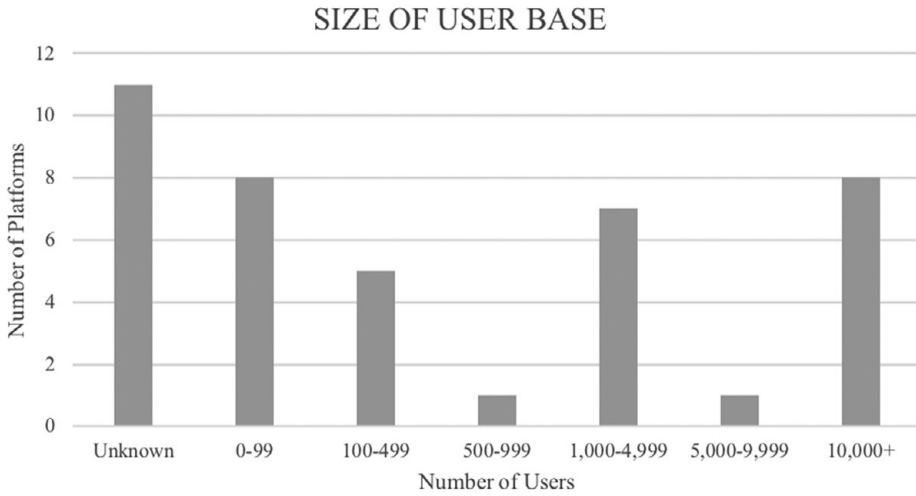
SIZE OF USER BASE

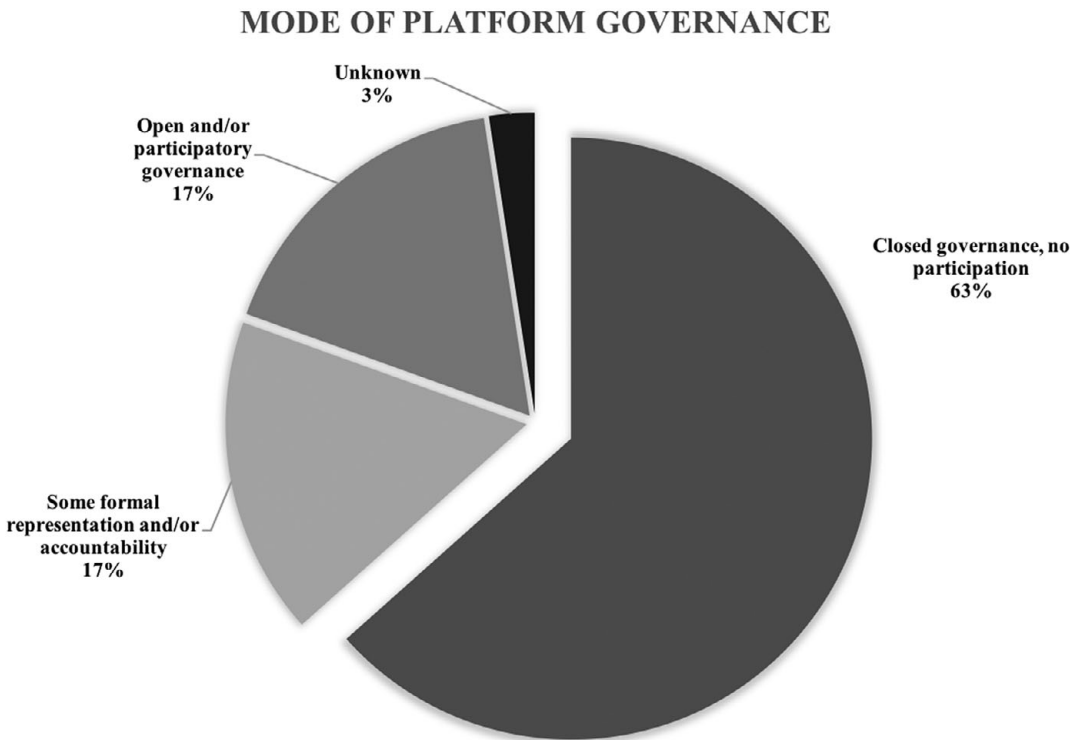*Figure 8.* Size of User Base.

MODE OF PLATFORM GOVERNANCE

Figure 9. Platform Governance.

4.11. Platform features

The platforms offered a multitude of tools and features (see Figure 10), including different types of exchange orientations which are distinct, yet complementary to one another. Many had compendiums (59%), which we understood as catalogs of best practices, case summaries, policies, or other sustainability innovations, though few compendia drew on large datasets. Over half had a login feature (61%), and many
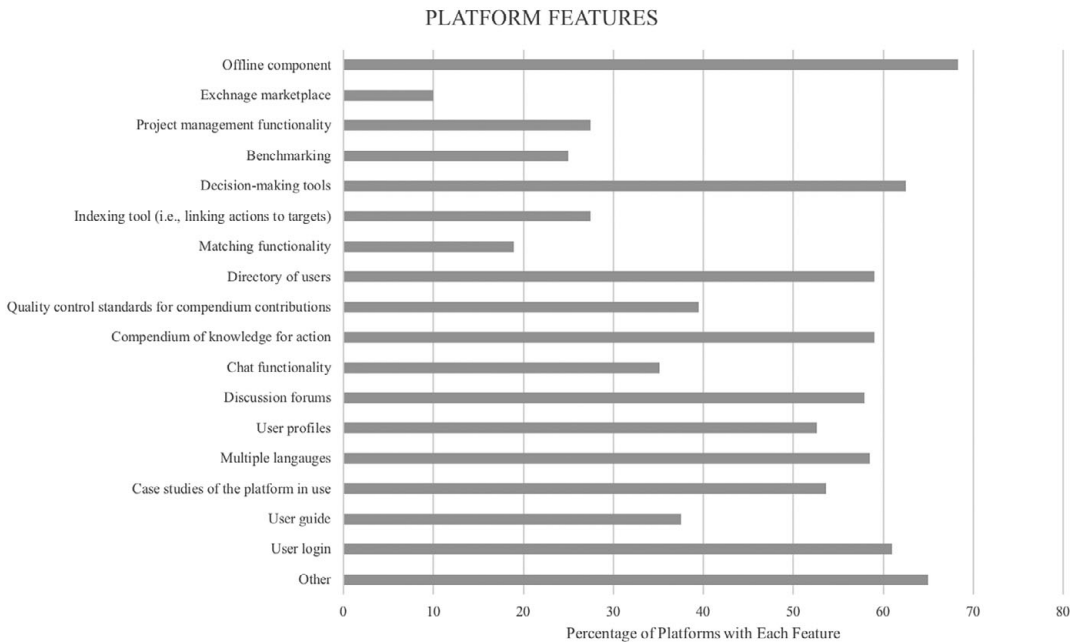
PLATFORM FEATURES

Figure 10. *Platform Features.*

allowed users to search for other users in a directory (59%), engage in forums (59%[11]), or message or chat with each other which would allow for 1–1 interactions (35%). Less common were more advanced features, such as benchmarking tools, which allowed users to calculate impact or progress on select sustainability goals (25%). Indexing was also less common, with a little under a third of platforms (28%) offering a tool that linked local sustainability indicators to higher-level targets or goals, such as national targets or global SDGs. Finally, about a quarter of platforms (19%) provided some sort of matching service, which connected users with resources for addressing their sustainability questions or issues. Interestingly, a high number of platforms ran in parallel with offline components (68%), which included activities such as in-person conferences, workshops, or regular member meetings. Many also offered additional features not explicitly coded in our analysis (65%), whereby social media profiles, such as Facebook pages and blogs, were especially common.

Concerning usability, many platforms were only available in English (41%). The high number of English-speaking platforms indicates the presence of an Anglophone bias within the digital architecture. Somewhat surprisingly, well under half offered users a guide on how to use their platform (38%). A little over half offered case studies that illustrated the use of their platforms (54%), suggesting there is significant scope to scale up self-presentation, which is particularly important for platforms with action-orientated missions. For conceptual definitions of each feature, please refer to the open-source database that accompanies this article.

5. Discussion

While some of the platforms assessed provide instructive case studies, few analyze more deeply how system change occurs and why interactions between SDGs matter. The SDGs are nevertheless an integral feature of many sustainability platforms, which shows that the 2030 Agenda has led to increasing stabilization of institutionalized discourses. Mirroring Strasser et al.'s (2019) 3D model, this study

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[11] NB: the methodology did not include any scope for analyzing the content of discussion on the forums.

demonstrates that the SDGs are widely referred to and structurally embedded in the architecture of a large proportion of digital platforms. It remains to be seen whether the SDGs will eventually crowd out, or complement, existing initiatives that purposefully (or not) have decoupled their action catalogs from the SDG model and use other models instead.

The fact that only one-third of the sample explicitly targeted entities based in the Global South suggests that there is still an inherent bias in digital platforms that promote trans-regional innovations, rather than a robust global peer-to-peer exchange on sustainability issues. We were unable to assess whether digital platforms are building additional capacities over time to engage in sustainable actions, nor how these changes occur within and across different locales, but this would warrant further, more detailed research.

Based on our analysis, we suggest that a new level of cooperation and transdisciplinary knowledge is greatly needed. A global circuitry that facilitates the sharing of local innovations so that best practices and insights can be adapted to unique local needs is vital for the governance of SDG localization. If sustainability platforms are to realize their promise of addressing the knowledge-action gap within particular local contexts, more open, collaborative, and multi-level structures of governance will be needed. Of the platforms we reviewed, only a third had a system of governance that allowed for some level of stakeholder participation. Who decides what is sustainable has a normative impact, especially as related to issues of equity and justice (Köhler et al., 2019), which underscores the importance of pluralism, knowledge sharing, and democratic decision-making. Future efforts on digital sustainability platforms should be context-sensitive and iterative, relating local and global issues and working within a platform concept to help address challenges for inclusive and adaptive governance, providing a much-needed mechanism for the global exchange of local innovations.

The transdisciplinary turn in digital innovation emphasizes the need for actionable knowledge that is cocreated with practitioners across sectors. Considering the enormous challenges and limited resources local leaders must work with, coproductive processes are necessary to generate new solutions to increasingly complex challenges and allow buried but promising practices to be brought to the surface. Codesign of sustainability platforms with end-users is therefore vital, but this remains the exception rather than a common practice. Our results found that most of the knowledge action platforms we assessed lacked participatory governance and mainly were created by government or civil society. There is scope for the private sector to also lead on providing an interface for knowledge action platforms and there exist many commercially available digital solutions that support sustainable impacts reporting. These are part of the sustainable digital architecture, but the commercialization of these platforms hampers their interoperability with government or civil society-oriented exchanges, and they often come with a hefty price tag that excludes the use of civil society or local governments that lack resources from their use. To effectively scale up action and multilevel impact measures, it is important that knowledge exchange between commercial sustainability platforms, government, and civil society is not compromised by the inability to pay. Finding resourcing solutions, such as cascading licensing fees for all service users, that allow equitable approaches to participate (and opportunities for open-source functionalities) would be a significant step forward in creating greater participation in their ongoing development and use profile.

A reciprocal and inclusive sharing of knowledge (including indigenous knowledges) could improve the availability and accessibility of information on sustainability innovations for local stakeholders, deepening insights based on learning from others' practical experiences. Platforms can also help to deepen the integration of scholarship and practice, not just by providing more easily interpretable research (as many platforms do), but also by facilitating direct connections between academics with specific expertise and "local actors" who need help to adapt and customize scientific solutions (e.g., as with living labs or University-based accelerator programs). This could advance both scientific understanding and local decision-making in climate governance and gain empirical insights into live sustainability pathways, improving empirically based system change models.

Researcher-practitioner knowledge sharing could easily be enhanced through the application of cutting-edge digital technology, such as blockchain and visual analytics, to develop a digital knowledge-action platform that collates and synthesizes user-generated content by theme and region. Such technologically advanced platforms could enable the reporting and benchmarking of progress

against existing SDG frameworks, while also enabling local-level customization of indicators, sustainability initiatives, and cultural learning that promotes reinforcing sustainability benefits. Sustainability indicators could be synthesized at different scales or between frameworks, for instance using AI that produces a comparability (best fit) score and thereby allows users to confirm whether suggested indicators match, or if these should be modified based on organizational needs. Data fields between indicator frameworks could then be cross-referenced, allowing data to move more easily between data models as well as lessening data transaction costs (with the option of selected data to remain anonymized and not flow through a global data chain). Much of this potential remains unrealized.

A digital sustainability platform designed in this way could also include measures to monitor and analyze areas that prevent the promotion of sustainable benefits or might contribute to negative outcomes that thwart them. This would allow for a better appreciation of the human, normative aspects of sustainability data management (Asokan et al., 2020) and their relation to sustainability pathways. Incorporating innovative computational methods, such as AI and Big Data, could help predict correlations and trends, but only insofar as this is centered within a qualitative account of different user group perspectives and contextualized accounts of how particular configurations affect localized or thematic ecosystems (see also Asokan et al., 2020). An organizational readiness index could be developed to guide users seeking to enhance their sustainability impact.

Above all, we suggest that these efforts should not reinvent the wheel. Much ground has already been covered by existing sustainability knowledge-action platforms, and the fragmentation of the field presents an obstacle to progress. What is needed to overcome this issue is an increased interoperability of different platforms through synergistic, federated processes or, in short, an orchestration architecture (see Blaschke et al., 2019).

To provide the most comprehensive approach to capturing sustainable actions through digital platforms, we suggest that further research is carried out to explore how platform organization and governance affects global digital transformation and learning ecosystems of transition in different contexts. This would help assess the geography of the diffusion of sustainable practices and the generation of new pathways, or trajectories, toward different sustainability modes. The correlation of actor and system characteristics can also provide insights into optimal organizational capacities and propensity toward certain types of innovation, as well as the system-actor qualities that create barriers to action and institutional lock-ins. Thus, change in regions, contexts, and network orientation and their impacts on transitions or transformations can be visualized. More research in this area is needed to measure the extent to which the SDGs encourage "building back better" in the wake of the COVID-19 pandemic.

There is much potential to extend the offer of some platforms to cater to different audiences, such as local government and community actors, if greater synergies between data sources could be achieved, for example, via an app. This raises the issue of data management and how policy measures could be designed to facilitate data-driven innovation. More research is required on whether issues relating to data sharing, ownership, interoperability, and integration could be managed differently to what we know from social media platforms, in the case of sustainability platforms designed to serve the "greater good" of sustainable futures. This is a particularly pertinent issue in the wake of the increased hacking and data security risks, or even the potential of "God-like" AI and greater machine intelligence and its potential detriment to society.

In addition, were there to be greater (financial or nonmonetary) incentives to encourage the collection, disclosure, and sharing of data, these would necessarily need to inspire trust and engagement in data governance, all of which are likely to differ across regions. Stakeholders with different interests and motivations could facilitate data sharing whereby engagement in a platform could be multiplied through a Regenerative Value (Burnett, 2022): a value generated when, and only when, other forms of value (i.e., financial, material, social, human and natural) are used in sustainable ways. If an organization was found to be employing other forms of value sustainably, it would earn Regenerative Value dividends, which it could invest in further sustainable programs within the platform ecosystem, such as sustainability initiatives in the wider community, or donating resources to fund sustainability projects in developing countries.

6. Conclusion

This article presented an overview of the rapidly expanding field of digital sustainability knowledge-action platforms, and our analysis highlighted associated opportunities for accelerating sustainability transformations, as well as some persistent limitations. We found that currently available sustainability platforms provide an array of resources for local actors to help address the knowledge-action gap. Many of the important criteria that we identified, as reflected in our coding scheme, were represented in the platforms that we reviewed, suggesting that many platform creators are aware of existing knowledge-action gaps and actively developing tools to help bridge such gaps. We found the breadth of features offered especially encouraging for the future of the platform economy, especially when considering its current stage of nascent experimentation. Indeed, the recent proliferation of sustainability platforms illustrates the growing recognition of the important role that such technology can play in addressing knowledge-action gaps, particularly when it comes to multi-level governance and the localization of the SDGs.

Despite these positive findings, the platforms that we reviewed often lacked a systematic alignment between local targets and international priorities, which can confuse translatable comparison for localized understandings of shared goals. Although the platforms facilitated an exchange of knowledge, each had limitations in its ability to widely share information and there was a lack of interoperability between platforms. The tools and frameworks offered to assist local agents in identifying appropriate actions could be more strongly aligned with the implementation of the overarching and comprehensive sustainability agenda defined by the SDGs. Some online providers served users at a national or regional level, while others addressed a global audience, though rarely accommodating a diversity of languages, affecting the potential for translocal innovation across regional and different linguistic communities. We suggest that a holistic and systemic sustainability knowledge-action platform with an orchestrating architecture between currently disjointed platforms could encourage the upscaling of sustainable solutions and offer the potential for wide-ranging indicator synthesis at different scales and provide a more concrete digital crux with which to innovate locally. Given the wide use and popularity of the SDG framework, platforms designed accordingly provide opportunities for a common language and alignment between sustainable actions and research worldwide. At the same time, the SDG framework could in this way be tested empirically and improved as needed, ideally in time for a reassessment by the UN in 2030.

We recommend greater research to determine how data-driven innovation can become appropriately embedded in national and local knowledge management systems and in the mechanisms required for a user-driven global platform to be effectively regulated. For instance, undertaking a qualitative assessment of the nuances of discussions on forums on such platforms and how these differ across actor groupings and regions. This would help determine whether incentives for local actors to integrate sustainability initiatives across different contexts are readily accessible, and the degree to which they provide a universal greening incentive to create systemic change globally (i.e., how much can such incentives encourage translocal innovation). While there are increasing mechanisms that promote circularity, many such incentives are still lacking, insufficient, or not widely accessible.

Through the promotion of cobenefits, interconnectivity, and adaptability among environmental, cultural, and political contexts, as well as enhanced interoperability amongst platforms, a federated digital platform could better support research and local-to-global actions among diverse populations (i.e., including local actors disproportionately affected by climate change). This could foster an integrated manner to exponentially scale public and private sustainability actions and drive innovation worldwide.

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