Can Sustainability Knowledge-Action Platforms Advance Multi-level Sustainability Transitions?

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Abstract

In an effort to share local knowledge and best practices, online sustainability knowledge-action platforms of various types have proliferated. We conducted a review of 42 online sustainability knowledge-action platforms, which we define as digital tools that seek to manage and organize (local) knowledge and activities to advance a sustainability agenda. This interdisciplinary paper analyzes the structure and functionality of existing sustainability platforms through a systematic coding process. The coding is based on a review of the key issues highlighted in three bodies of literature: i) localization of the SDGs, ii) digital platforms and iii) multi-level governance of sustainability transitions. Our analysis indicates that numerous online collaborative tools, while offering an array of resources, struggle to provide context-sensitivity and higher-level analysis of the trade-offs and synergies between different sustainability actions. Context sensitivity and systemic thinking are essential, however, to align local priorities with international priorities like the Sustainable Development Goals (SDGs). SDG localization adds another layer of complexity where multi-level governance, actor priorities and institutional logics may generate tensions as well as opportunities for intra- and cross-sectoral alignment.

Our paper offers a series of recommendations for accelerating local sustainability innovation with sustainability-focused online tools. We discuss various policy measures and approaches to facilitating data-driven innovation and how these might address issues relating to data ownership and accessibility, data interoperability and integration (particularly between the Global South and North), incentives relating to data collection, sharing of data, and engagement in data governance. We argue that, while showcasing and exemplifying local actions, an integrative platform that leverages existing content from multiple extant platforms and provides additional functionality could better assist local leaders to accelerate local to global actions across multi-level and complex system change requirements. We posit the need for an integrative open-source and dynamic global online data management tool that would enable the monitoring of progress and facilitate peer exchange of ideas and experience among local government, community and business stakeholders.

1 Introduction

Despite the increase in global attention focused on sustainability challenges such as climate change, biodiversity loss and ecosystem destruction, the implementation of effective and innovative solutions at the local level is often overlooked. Local leaders are ill-equipped to address these "wicked problems" (Rittel & Webber, 1973) at the community or municipal scale. Our focus in this paper is on digital platforms that seek to support local sustainability initiatives and we ask how their design might prompt multi-stakeholder translocal sustainability outcomes. While sustainability action at the local level is often context-specific and unique, some innovative approaches and best practices are of general value to communities worldwide and thus should be widely shared.

Local sustainability initiatives have progressed since Agenda 21 - a non-binding action plan of the United Nations for sustainable development (UN, 1994) within the broader "sustainable community" domain. These include alternative approaches developed within more counter-cultural social movements such as eco-villages, Transition Towns and intentional communities. Other templates emerged from several prominent networks of local actors,

including ICLEI[1] and C40, which have contributed to the sharing of good practices and case studies.[2]

The scope and specificity of these local sustainability initiatives vary widely. Some define sustainability broadly while many initiatives focus strictly on climate change and, of these, some are geared exclusively to mitigation while ignoring the adaptation aspects of climate change action, as detailed in the 2015 Paris Climate Agreement. Others are linked to the Sustainable Development Goals (SDGs) which offer a more comprehensive pathway for collective action on sustainability across a broad spectrum, but while ambitious, these are an imperfect strategy for consolidating sustainability at different scales.

Signatory nation-states are free to develop their own indicators to track progress on the SDGs in their jurisdictions, and considerable progress has been made to establish a framework that allows data to be aggregated globally. Yet national data sets have limitations as they struggle to report on diverse relevant actions on the ground. Local-level reporting against the SDGs is uneven and often altogether lacking, particularly in the Global South[3] (Asokan, Yarime, & Onuki, 2020). Even in a developed country such as the UK, the extent of monitoring and reporting on SDG implementation within local systems has been low (UKSSD/LGA, 2020). In addition, many of the agreed indicators did not receive extensive commentary from wider stakeholders, indicating that their ontological conceptualization was divorced from local-level priorities (Asokan et al., 2020).

In addition, many composite (weighted) or aggregated indicator sets can conflate undeclared normative assumptions (Asokan et al., 2020): robust indicators that decouple a range of specific sustainability outputs into different frameworks is also urgently required. Meanwhile, with little consensus on the parameters of sustainability issues, local leaders often act from an immediate need to find solutions and do not always actively document their progress on advancing sustainable action, nor the challenges in doing so. Narratives on what sustainability is have been clouded by a splintering of the sustainability discourse into sets of competing logics – urban resilience, urban low-carbon transitions, smart urbanism and urban securitization (Hodson & Marvin, 2017). Limited resources further constrain local leaders and officials' scope for taking action, particularly in the Global South.

The transition to digital technologies offers great promise to close knowledge gaps and disseminate socio-technical sustainability solutions. The "digital economy" is a term used to describe how economic activity is increasingly being shaped by digital technologies that affect communication, business models and activities and social interactions (Soto-Acosta, 2020). The Covid-19 pandemic has accelerated this digital transition, which presents new opportunities to advance sustainability scholarship, innovation, collaboration and action towards a green recovery. At the same time, however, greater recognition of the role of different local contexts and places – which have various levels of knowledge, resources and organizational capacities (Uyarra & Flanagan, 2010; Wanzenböck & Frenken, 2020) - as laboratories for experimentation with sustainable solutions is urgently required, given that scale and geography are fundamental factors in translating resources and knowledge into meaningful actions and outcomes.

A recent proliferation of sustainability platforms that aim to document action towards sustainability and lesson sharing – to varying degrees - speaks to the need for qualifying the extent to which they cater to a diversity of local needs and approaches and how they can ameliorate extant challenges in sustainability data management. The resources required to create and populate an effective sustainability platform are considerable and might not provide the support and information needed by local stakeholders unless their design is well thought through. Moreover, platforms are by their nature socio-technical phenomena; therefore research on such platforms sits within the study of sustainability transitions, and more specifically, Technical Innovation Studies (TIS) (Smith, Voß, & Grin, 2010). In this paper, we seek to understand how the socio-technical configuration of these platforms mediates their potential for depth (impact), width (reach) and length (stability and duration) (Strasser, De Kraker, & Kemp, 2020)) beyond the current phase of experimentation, towards stabilization of the sustainability platform scene.

The purpose of this review article is threefold: (1) identify, categorize, and assess sustainability platforms to provide a state-of-the-art in the field; (2) critically examine the role of platforms in meeting SDGs; and (3) advance strategies to accelerate solutions to sustainability crises. We begin by defining the phenomenon of 'digital sustainability platforms', exploring issues relating to localization of the SDGs, as well as challenges and opportunities within the politics of multi-stakeholder transitions.

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[1] https://iclei.org/
[2] https://www.c40.org/
[3] See: https://dashboards.sdgindex.org/rankings which outlines the ranking of progress made on the SDGs out of 24 countries,

with those in Scandinavia improving across the SDGs the most and some Central African countries the least.

2 Literature Review

2.1. Digital Platforms: A tool to advance sustainability?

Digital Platforms are a promising new technology that offers solutions to connect people who share a common purpose, in this case, sustainability. The first papers that focused on digital platforms and sustainability appeared in the mid-2000s, reflecting the move towards a "platform revolution" (Parker, van Alstyne, & Choudary, 2016). The literature now covers digital platforms and interfaces with a range of approaches: from smart cities, the sharing economy and platform cooperatives, to distributed energy sharing, blockchain technology and its role in technological innovation; there is a limited literature that explores digital innovation and platforms specifically relating to the SDGs (see Fuster Morell & Espelt, 2019) and the Global South (Onyango & Ondiek, 2021). Meanwhile, there are some key issues relating to how platforms are defined, which affects their classification and therefore the contribution they may make to multi-level, localized efforts towards sustainability action.

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 on which something else can stand, the dawning of the digital era established and popularized the term's use in reference to various technologies and technology-enabled business models, often with very little in common with one another (Gillespie, 2010). No widely accepted definition of an online platform yet exists. Different classifications of 'platforms' may be used interchangeably and there is a lack of conceptual clarity (Bream Mcintosh, 2020; Zarra et al., 2019). Since the 1990s the term has adopted a somewhat platitudinous quality and, in the absence of any substantive meaning, the preferred meanings reflect multiple vested interests, leaving the concept not only vague but slippery and political (Hansen & Mikkola, 2004; Lamarre & May, 2017). Accordingly, this section seeks to clarify and justify the particular definition chosen to frame our research.

Broad definitions of 'platforms' tend to refer to shared or traded services between users and may include social media, search engines, e-commerce sites (Zarra et al, 2019). 'The Platform Economy', moreover, is a popular term used to describe digital exchanges and business models (Fuster Morell and Espelt, 2019). Codognone,

Abadie, and Biagi (2016) suggest platforms that match different user groups and make transactions more efficient, offering an intermediary function. Platforms can be for-profit and monopolistic and follow the capitalist model (such as Uber), or can be run as social enterprises to support the sharing economy and the pursuit of the Commons. Evans Evans and Gawer (2016) further refine the definition of a platform according to the following criteria:

Table 1 - Platform classification - adapted from Evans and Gawer (2016, p.9) and Zarra et al (2019, p.4)

Platform category	Examples	Detail
Transaction platforms	eBay, Tencent and Uber	Facilitate transactions between users that would be impossible or difficult to establish otherwise
Innovation platforms	iPhone	Technological building blocks that support the development of complementary services or products by users
Integrated platforms	Google	Combine features of transaction and innovation platforms
Investment platforms	Priceline Group	Companies that have developed a platform portfolio strategy and act as a holding company, active platform investor or both
Non-commercial platforms	Carpooling platforms where the cost of the ride is shared and there is no additional fee	'True sharing' platforms that are free of charge or on which only the costs are covered, often within the classification of the collaborative or sharing economy

In keeping with the work of Simone Cicero and other proponents of Platform-Ecosystem Thinking (PET), 'a platform' herein refers to "a strategy to mobilize and help

an ecosystem produce shared value and express its potential" (PDT, 2019). The PET approach is well-suited to our research agenda given its focus on human relationships and networks over technical specifications and given that these relationships and networks are highly pertinent to the dynamics of local transitions. The 'ecosystem' referred to here is the ensemble of interacting entities, whether individuals or organisations, that either take part in the exchange or have the potential to do so.

PET stipulates that this 'strategy' will typically comprise *a connective, aggregative tool* and an accompanying *set of conventions* which together facilitate two-sided or multi-sided peer-to-peer (P2P) connections and transactions, often between the 'peer-producers' and 'peer-consumers' of a range of goods or services (Choudary, 2016; Cicero, 2016; Cicero & Heikkilä, 2020; Hagel, 2016). 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 in the anticipation of reciprocity (Benkler, 2006: 117). In light of this definition, and in spite of others (c/f Kloppenburg & Boekelo, 2019), platform strategies can be seen manifested in physical places – such as co-working spaces for social innovation (Cicero, 2016) – as well as online. Our focus in this enquiry remains, however, solely on the latter.

2.1.2   The promise and peril of digital platforms for sustainability transitions

Digital platforms allow for unprecedented professional and social networking among communities that are most vulnerable and disproportionately affected by the impacts of climate change. Schut, Cadilhon, Misiko, and Dror (2018) suggest that Innovation Platforms can allow for new technologies to scale out beyond their original scope if they are sufficiently embedded into public and private networks, helping to strengthen structural and longer-term engagement between stakeholder groups. These platforms can 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 within "a space for negotiation, conflict and dealing with power dynamics" (Perry, Patel, Bretzer, & Polk, 2018; Schut et al., 2018, p. 98).

By enabling new forms of sustainable consumption and fostering behavioral change among consumers, the

Platform Economy can play a pivotal role in advancing sustainability. However, while offering promise for synergizing multi-stakeholder groups and interests, some markets within the Platform Economy have caused "the death of distance", or an overlooking of local nuances, and their proliferation and disruptive impact has enabled "unprecedented access to information, new goods and services" (Zarra et al, 2019, p.8, p.i). Some online marketplaces are implicitly neoliberal, with the assumption that everyone should be tied into the global economy (Zarra et al, 2019) 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 term platform under false pretenses, such as presenting themselves as 'collaborative' when they are not, or glossing over wider issues of gender and inclusion (Fuster Morell et al, 2020).

Digital cooperatives, such as Platform Cooperatives,[4] offer opportunities to cultivate the Commons[5] and prefigure sustainable actions and fairer outcomes in what is more recently framed within the concept of 'Regenerative Platforms' (Cicero, 2021). While such digital platforms are proliferating at a fast rate, 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 note that they received no entries in the 'learning from failure' category when identifying their case studies (Schut et al, 2018).

Insufficient research exists on digital platforms' economic, social and environmental impacts and their scope to enhance sustainability outcomes, especially given that many marketplaces do not undertake sufficient 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 et al, 2020). For example, Kawakubo and Murakami (2020, p. 1) report on experiments in Hokkaido and Kyusu, 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 and, even then, required a degree of modification, or 'localization' before they could be applied. Meanwhile, the SDG Portal provided by

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[4] https://platform.coop/
[5] Commoning is referred to here as "a practice of collaborating and sharing to meet everyday needs and achieve well-being, of

individuals, communities and lived-in environments"
https://www.lowimpact.org/lowimpact-topic/commoning/

the German Association of Cities and Bertelsmann Foundation[6], for now, is more focused on measuring and comparing achievements relating to SDG indicators than facilitating peer-to-peer sharing of ideas within the solutions space.

There are calls for more integrated and localized approaches. A recent report by the Sustainable Development Solutions Network's 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) has proposed a 'digital ecosystem framework,' according to the TReNDS report. 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 & 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 also suggest that marketplaces - which we also suggest could be within the non-commercial or sharing economy sector - could encourage reporting on social and environmental commitments against known certification systems. This could lead to improvements to local government sustainability reporting since the clients and supply chain of local government could enhance localized ESG commitments against a certification or benchmarking schema. These authors also suggest that there should be a harmonized reporting system that would enable all platforms to align their organizational strengths and weaknesses towards sustainable outcomes, with clear targets and an assessment of the progress towards 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 - and we suggest citizens - are motivated to choose greener choices by rewarding those who engage with more sustainable sellers to promote a circular economy through an offer of green rewards and incentives (Zarra et al, 2019). This suggests

the need to explore platform governance within a harmonized local-global monitoring system that can also incentivize sustainability benefits within the ecosystem of platform entities.

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 just for all worldwide. The 17 goals and its associated 165 targets and 230 indicators seek to map the key elements necessary to transform global systems[7]. While alignment with the SDGs may be voluntary for the signatory nation-states such well-intentioned 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 suggest that the concept of localizing the SDGs is 'a relatively new and unexplored concept' and Nationally Determined Contributions (NDCs[8]) are not yet well-related to local action. The implementation of the SDGs with and through sub-national government is pivotal to achieving them. However, the 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". Leyden and Deutschmer's (2021) Policy Brief on localizing NDCs with inspiration from the 2030 agenda 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)[9] - 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 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-

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[6] https://sdg-portal.de/

[7] See https://www.unsdsn.org/sdg-index-and-monitoring for the latest progress on progress towards the SDGs (though note national the data is often divorced from local context), a key issue raised in this paper.

[8] Nationally Determined Contributions (NDCs) are a key to translating the goals of the Paris Agreement into concrete action.

[9] Local implementation Plans, inspired by SDG Voluntary National Reviews (VNRs).

Moya, Koike, Ota, Kataoka, & Fujino, 2020). This may explain why only a few dozen among the millions of local jurisdictions globally have reported on the SDGs. Community ownership is occurring in some places, such as the SDG Forum in Canterbury and a 4-step reviewing process in Los Angeles. However, there is almost no example of VLRs being linked to national processes, suggesting 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 sub-national 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, Siragusa, & Proietti, 2021, p. 6). In short, SDG localization seems to be almost impossible without setting specific local targets that make sense to local policymakers and actors.

The approaches to remedying localization issues differ, however, and tend to fall within two broad categories: increased i) prescriptiveness and monitoring and ii) 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).[10] ESPON prepared an SDG localizing tool for the EU "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 towards the SDGs in the EU context and particularly at the national level" (ESPON, 2020, p. 7).[11]

The problem remains that a locally-led SDG implementation approach could make it difficult to assess and compare progress towards the SDGs or sustainability transformation more broadly. This suggests that an alternative, decentralized, diversified and bottom-up process of data aggregation may be required to reveal what solutions local actors are developing and also support peer exchange of innovative ideas at the sub-national level. As a recent Brookings report notes, SDG implementation will be compromised if perceived as a "compliance exercise" and 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 (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. These participants further suggested a small sub-set of indicators, a "data floor" that could be common to cities pursuing the SDGs, 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 is to improve multi-level governance and create a national enabling institutional environment. In addition, to galvanize the localization movement (CCC, 2021), particularly to encourage transformation within the context of the Covid-19 pandemic (UCLG, 2020).
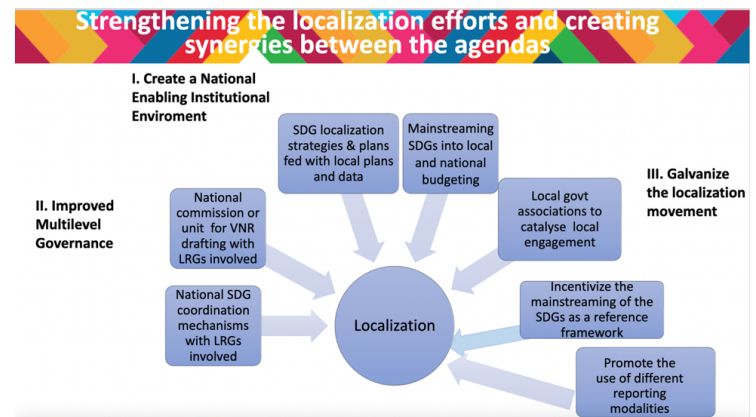

Figure 1 – Measures to strengthen SDG localization (CCC, 2021)

Any such solution should be globally accessible to ensure that developing countries are not left behind. As Rahman (2020) points out, Asian countries are experiencing challenges in disaggregated data and inclusive implementation at regional and sub-regional 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?*

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[10] 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, Evans, & Neij, 2018)

which too are often divorced from the local level (Merritt & Stubbs, 2012).

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

A pragmatic compromise solution to these 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 an equally wide diversity of SDG solutions, having noted earlier that the SDGs are a transformation map, and not the transformation territory. Such innovative approaches should be encouraged, as Szetey et al. (2021, p. 2) suggest to "co-create pathways to their achievement" (Szetey et al. 2021., p2) with solutions disseminated 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, Barinova, Loginova, Edward, and Ponedelnik (2019, p. 219) as "deep localization" while others refer to such specific local needs as "community-defined sustainable development goals (CDSDGs)" (Winans, Dlott, Harris, & Dlott, 2021, p. 2).

UCLG also suggests the necessity of intersectoral collaboration as a prerequisite for "systemic action" (see Tan et al., 2019), both through multi-stakeholder and multi-level partnerships and in the implementation, monitoring and evaluation of the SDGs (UCLG 2020, p.120; 10). This role should not stop with inspiring local governments but extend to all sectors, as "many countries are yet to discover the full power of local partnerships (between sub-national governments, enterprises, civil society, universities, philanthropies and communities) in SDG delivery" (Revi, 2017, p. ix). Many local governments may lack the technical capacity to map their own sustainability transformation arenas or to formulate adequate policies - suggesting additional support for capacity building is required (Regions4, 2018). However, doing so should not necessarily be in a prescriptive sense but one of coproduction with sub-national actors. As Caniglia et al. (2021, pp. 98-99) note, "in research, we too often try to direct processes of change but fail to and cultivate the relationships and conditions that allow for change to unfold." New types of learning to promote social and technical innovation that can cultivate innovation, new processes, methods and tools for effective multi-level governance are required.

2.3 Multi-level Governance in Sustainability Transitions

Multi-level governance and its influence on sectoral transitions is a key concern of sustainability transition scholars, reflected in the work of Geels' (2002) Multi-level Perspective (MLP) and Avelino and Wittmayer's (2016)

Multi-Actor Partnership (MAP) model. Thus, within contemporary research endeavors, there is often an action research imperative to co-create workable solutions for multiple stakeholders and to solicit sustainable actions, applying the normative assumption that sustainability transitions are inherently positive.

May and Marvin suggest that local government sustainability action "is not simply about formal governance and institutions, but the cultures that inform effective organisation" (May and Marvin, 2017, p.2). In other words, context matters: models for success cannot be readily imported to another setting. As Shami (2013, p.80 in May and Marvin) remarks, "what can be replicated are the approach and the philosophy behind [best practices] but not the procedures and activities."

For instance, the Mistra Urban Futures Centre developed Local Interaction Platforms (LIP) in the cities of Gothenburg, Cape Town and Manchester to bridge diverse forms of knowledge and expertise in the pursuit of sustainability. These LIPs were developed under the same general guidelines but adapted and implemented in different ways, which led to rich descriptive accounts of the factors that shaped local design and uptake across different contexts (May & Marvin, 2017). These performed the following functions: i) clusters for development of knowledge and innovation for urban sustainability; ii) a resource base for case studies and scientific analysis; iii) forging strong ties between the academic community and local knowledge; and iv) "showcases" for other cities and countries. Moreover, this project assessed different dynamics in cities, such as boundaries of knowledge production and receptivity; these became a vehicle for understanding national and city-regional connections and how these could enable effective sustainability transitions. As these authors suggest, LIPs "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).

While these results may be more reflective of multi-level governance and issues arising from LIP, there are important general lessons herein as to how digital platforms could be better designed. Perry et al. (2018) suggest that the necessary conditions for LIPs are: anchorage (commitment), co-constitution (flexible and adaptive partnership structures), context-sensitivity (reflecting local issues and challenges), alignment (align and embed within multi-scalar frameworks), connection (commonality and cross-learning) and shared function (boundaries for interaction within and between sectors). The financing of such initiatives also affects how relationships and power imbalances are played out in the

arrangements of platforms-funders. Meanwhile, the timing of the creation of new governance arrangements can be affected by processes of political (administrative) change. Additionally, 'platforms' that are well-embedded into existing urban and global projects help foster collaborative and comparative learning (May and Marvin, 2017, p.195; see Figure 2).

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). These authors also suggest that collaborative governance arrangements seeking to bridge messy inter-organizational relationships and goals with innovative engagement solutions are becoming 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 these dynamics (Shami 2003, p. 80 in May and Marvin, 2017) (also see Figure 2).
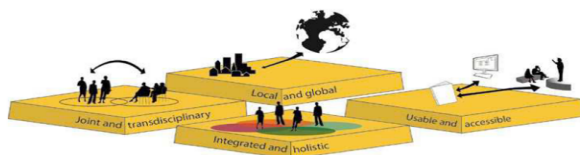

Figure 2 – principles of knowledge production – Kain, Nolmark, Polk and Reuterswärd (2011, p.18) in Perry et al, 2018, p.191

However, 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, Pettit, and Hoon (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 co-productive "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 be addressed through 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 is important for testing new technical and social innovations and recognizes that not all innovations can be readily transplanted across contexts, emphasizing

hybridity and inter-relationality that advances dualist debates to 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 to roll out best practice models elsewhere (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). Without a spatial consideration of sustainability issues, this may well lead to a "democratic deficit" between what policies should be developed and how, and where the logic of economic competition may necessarily outpace efforts to foster inclusive, localized approaches (May and Marvin, 2017).

3 Methodology

3.1 Conceptual Framework

There is no widely accepted understanding of "platform economy." As depicted in Table 2, several recent studies deployed sundry conceptualizations. For this research, we understand such platforms as an umbrella concept that refers to digital tools that seek to manage and organize knowledge and activities to advance a sustainability agenda at the local level. Specifically, here referring to "a strategy to mobilize and help an ecosystem produce shared value and express its potential" (PDT, 2019).

Blaschke, Haki, Aier, and Winter (2019) reviewed 46 papers on digital platforms to produce a bottom-up taxonomy of these phenomena, which is compatible with the aforementioned Platform-Ecosystem Thinking (PET). They identify four "layered modular" architectural dimensions (ibid, p.3) in what they term a "focused perspective to effectively capture the configuration of a given digital platform's components" (ibid, p.2): the infrastructure, the core, the ecosystem, and the services offered, which they determine to either exhibit an "exchange orientation" or a "design orientation". The various possible configurations of these dimensions, as shown in their discussions, converge on three "archetypes" of digital platforms, which are: the orchestration platform, the amalgamation platform, and the innovation platform.

Table 2 - Platform architectural taxonomy (Blascheke et al, 2019, pp.11-12)

Platform Architecture	Components
Orchestration Platform	Assemble federated networks—outward-looking, vertically disintegrated, and open-loop ecosystems—of platform-augmenting third parties through co-opetitive and inclusive platform profiles
Amalgamation platform	Assemble *private networks*—inward-looking, vertically integrated, and closed-loop ecosystems—comprising an exclusive selection of few private actors through monopolistic and assimilative platform profiles (p.11)
Innovation platform	Assemble unobstructed access to a *novel* digital infrastructure de-void of permissions

Blaschke et al also suggest that where platforms share similar characteristics these typically share identity architectural profiles. The platforms included in the sample assembled for this study all exhibit an 'exchange orientation' in their services, and are mostly aligned to the amalgamation archetype.

3.2 Data Collection and Analysis

Data collection occurred between March and June of 2021. First, a preliminary list of sustainability platforms used by English speakers 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 198 platforms. All platforms were screened for inclusion criteria. Only those platforms that fit our conceptualization, as described above, were currently active or under development, and targeted local change actors but promoted translocal exchanges were included in the analysis (Table 3).

Table 3 – Identified Platforms and sample size

Total number of potential platforms identified	198[12]
Total number of platforms coded	58

Total number of platforms screened out during coding process based on subsequent refining of codes	16
Total number of platforms included in final set for analysis	42

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). As Agnes (2000, p. 239) explains, a matrix is "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". Averill (2002, p. 856) further explains that in a descriptive matrix analysis, the data entered into the cells reflects "paraphrased, synthesized, or quoted content," which are systematically cross-referenced to identify similarities, differences, and trends. 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, outlined in the Introduction.

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 provide basic descriptive information about the platforms. The resultant list also included 35 descriptive codes, which as Turner (1994, p. 199) described, are 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 coding the same platforms and comparing codes. The results of our analysis are discussed below.

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[12] NB: since this is a *Working Paper*, the authors identified several platforms that are still yet to be coded which explains the higher total number of sustainability platforms identified and the relatively lower number actually coded.
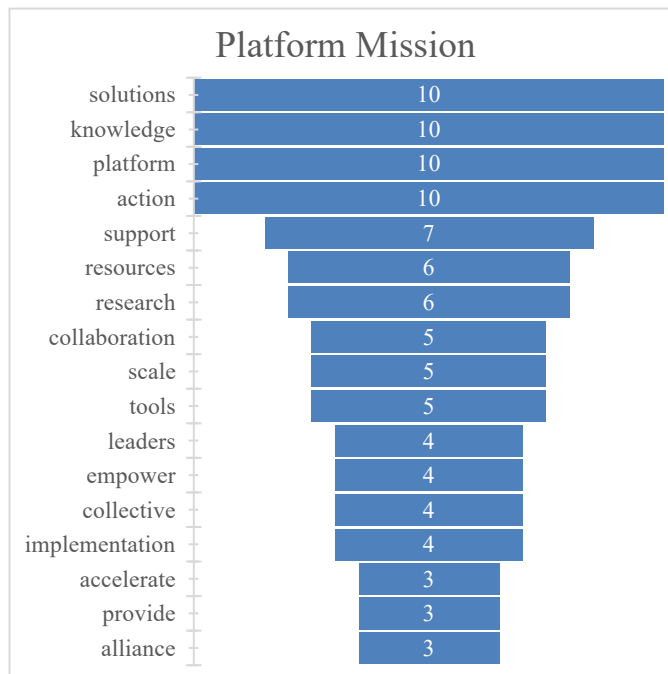
4 Results and analysis

Below, we outline the results of our analysis based on the coding approach taken by the authors and the significance of each of the categories in terms of the current global provision of sustainability platforms. We found that overall, there is no dominant one-stop provider of online services for local actors; coordination between available platforms requires a systemic approach to populate and cross-reference local-global actions against the SDGs and other sustainability approaches.

4.1 Geographic reach

Geography relates to the significance of translocal innovative capacities across geographic and linguistic boundaries. 57.1% of platforms defined their geographical scope as global, while those platforms focusing on a select range of countries and those working solely at the national level each represented 19% of the sample. Despite a majority working globally, only one-third of the sample explicitly targeted entities based in the Global South.

4.2 Mission

Mission relates to the platform's mission or purpose. The most common keywords identified related to 'solutions' generation, sharing 'knowledge' and cultivating 'action'.

Platform Mission

Keyword	Value
solutions	10
knowledge	10
platform	10
action	10
support	7
resources	6
research	6
collaboration	5
scale	5
tools	5
leaders	4
empower	4
collective	4
implementation	4
accelerate	3
provide	3
alliance	3

4.3 Number of Platforms founded each year

The number of platforms being established before 2016 was relatively low and stable, after which there was a steady increase in 2015 which signaled a sharp upturn in online platforms. Limited sample aside, the trend indicates that, overall, there is a recent accelerating growth in sustainability Digital Platforms. However, this rapid growth may be resulting in a crowded and confusing online scene, as users have the option to engage with many and varied platforms.
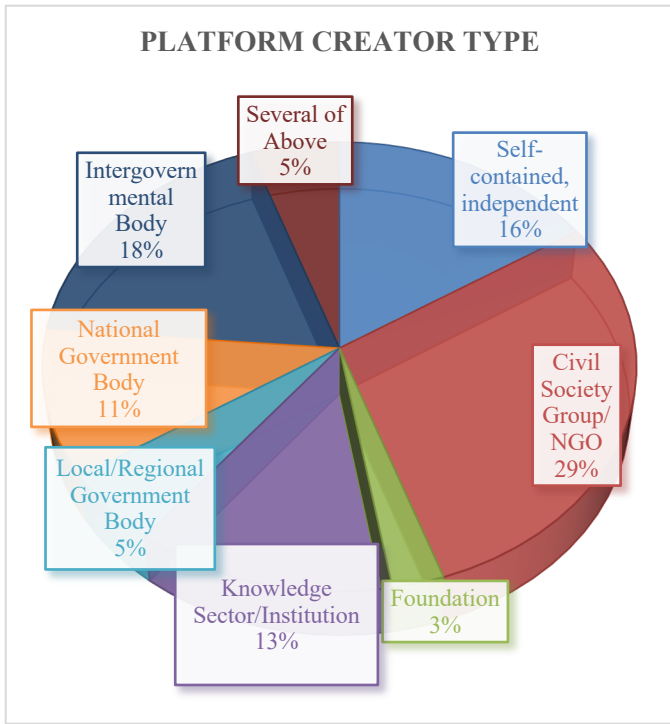

Number of Platforms Founded Each Year
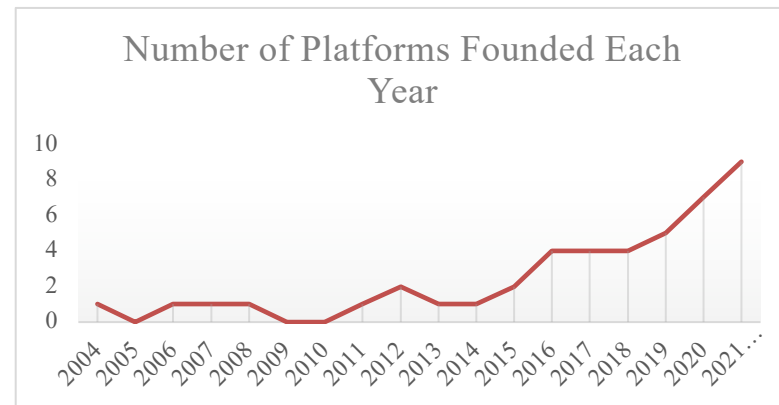
4.4 In-house or third-party tech support

71.4% of platforms appeared to have built their own platform sites or applications, while 28.6% appeared to have built on top of existing applications. These pre-existing applications included: Hivebright, Intercom, Zoho, Bubble Apps, and Open Social.

4.5 Creator type

The majority of platforms assessed were created by civil society and NGOs, followed by an intergovernmental body such as U.N. agencies, independent entities, including entrepreneurial startups, knowledge sector/institution such as the Wuppertal Institute or national government bodies, including German ministries. It was rare for a platform to have multiple creators. Although, it was common for platforms to receive financial support from multiple sources.

PLATFORM CREATOR TYPE

Several of Above
5%

Intergovernmental Body
18%

Self-contained, independent
16%

National Government Body
11%

Civil Society Group/ NGO
29%

Local/Regional Government Body
5%

Knowledge Sector/Institution
13%

Foundation
3%

4.6 Cost of Use

Most of the Platforms assessed were free to use, with only 10% having a paid-for feature and a small proportion having both free and paid for services. For example, B Lab, which provides certification for B Corps, offers its assessment tool to businesses for free but requires a fee for the actual certification.
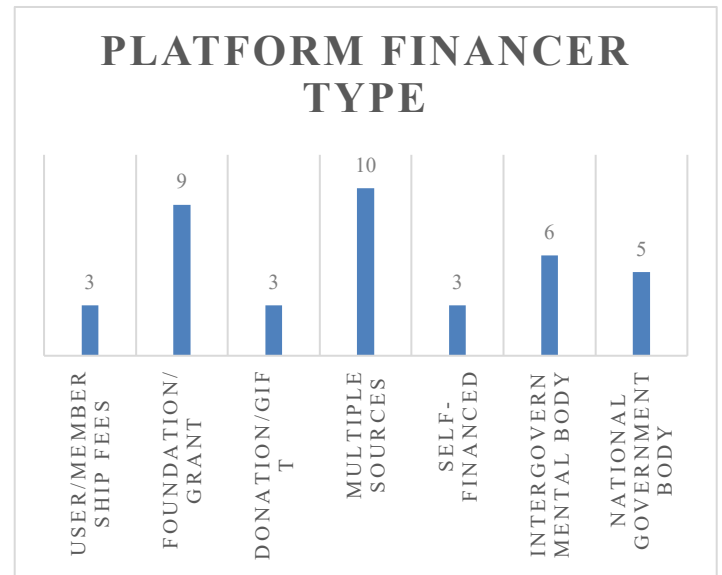
COST OF USE

NA
10%

Paid
10%

Hybrid
9%

Free
71%

■ Free ■ Hybrid ■ Paid ■ NA
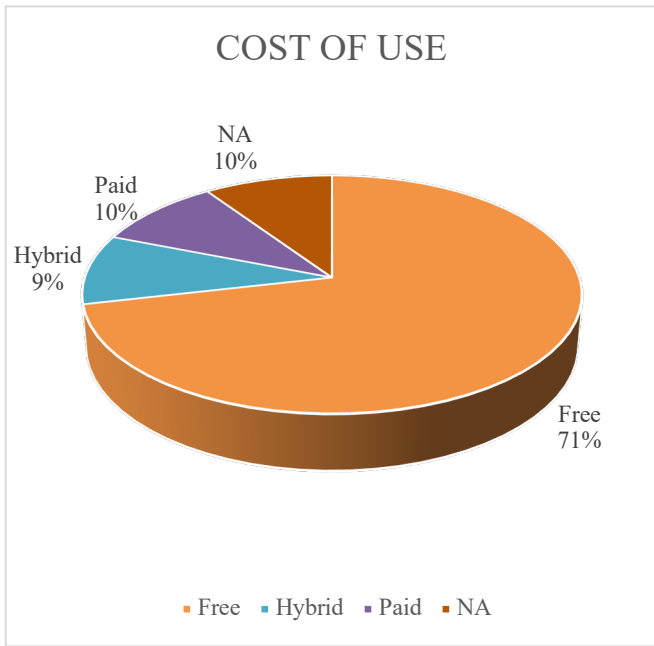
4.7 Platform financier type

Platform financier types often came from multiple sources, though often grants/foundations were a common funding stream. Few were funded by user membership fees, which is not surprising given the few platforms that charge for services. Interestingly, national governments were also a principal funding stream for platforms, with most being funded via German ministries. However, whilst the reliance on grants and external funding implies greater access for end-users, it is also important to consider politics and power dynamics when, for instance, a multi-lateral development bank may be financing a digital platform which may affect top-down accountability measures on sustainability actions.

PLATFORM FINANCER TYPE

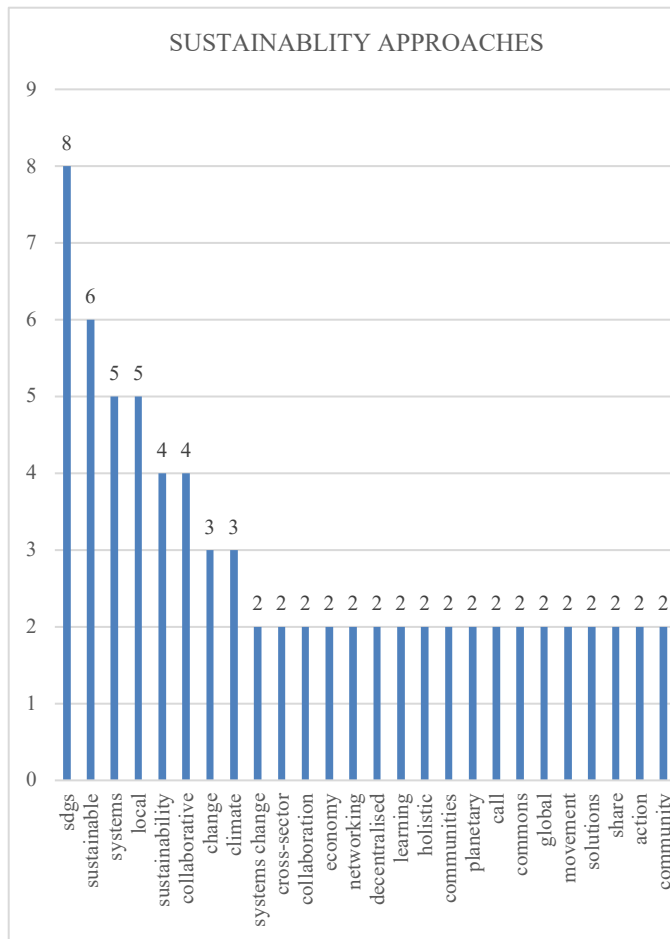| Category	Value
USER/MEMBERSHIP FEES	3
FOUNDATION/GRANT	9
DONATION/GIFT	3
MULTIPLE SOURCES	10
SELF-FINANCED	3
INTERGOVERNMENTAL BODY	6
NATIONAL GOVERNMENT BODY	5

4.8 Sustainability Approaches

Some, but not all, of the assessed platforms had an explicit focus on community or municipal level implementation of the SDGs. The SDGs were a clear driver for the raison d'être of sustainability platforms, which reflects the rise in the number of emergent platforms since 2015, when the SDGs were agreed by nation-states. Some platforms focused explicitly on the SDGs and did not embed wider approaches, for instance the UN's Local2030 platform.
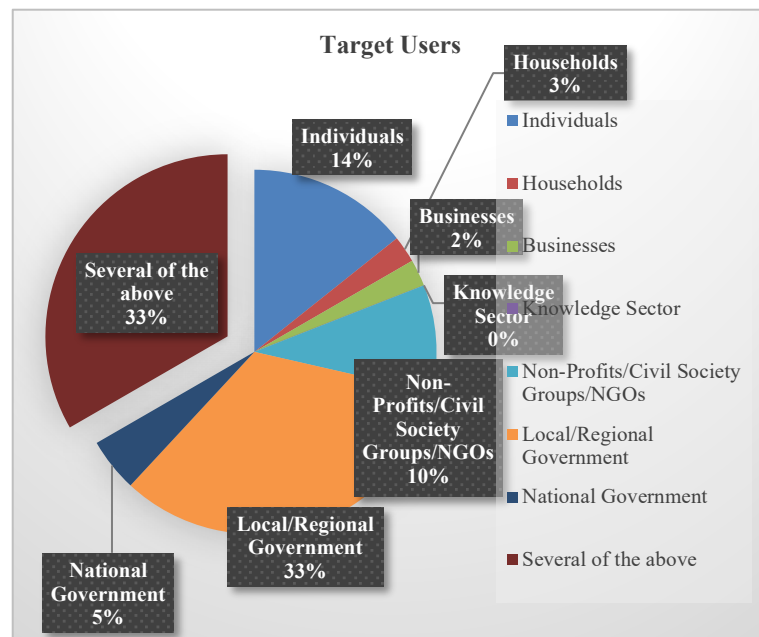
However, beyond the SDGs there were many other value drivers, such as sustainability more broadly, emphasizing local approaches and decentralization, networking and collaboration and enabling learning. Other approaches and frameworks, such as those targeted at eco-villages and Transition Towns (such as the Communities for Future

11

Collaborate platform) pre-date the SDGs, while some platforms focused on the environmental dimension of sustainability or the reduction of greenhouse gases (GHGs), such as the EU's Green City Accord or more integrated climate action plans.

SUSTAINABLITY APPROACHES

Bar chart showing frequency counts: sdgs 8; sustainable 6; systems 5; local 5; sustainability 4; collaborative 4; change 3; climate 3; systems change 2; cross-sector 2; collaboration 2; economy 2; networking 2; decentralised 2; learning 2; holistic 2; communities 2; planetary 2; call 2; commons 2; global 2; movement 2; solutions 2; share 2; action 2; community 2

Target Users

Pie chart showing Target Users: Individuals 14%; Households 3%; Businesses 2%; Knowledge Sector 0%; Non-Profits/Civil Society Groups/NGOs 10%; Local/Regional Government 33%; National Government 5%; Several of the above 33%

4.10 Size of User Groups and Partners

We were only able to obtain data on the size of user groups for a little over half of the platforms reviewed (64%). Of those, a third had fewer than 100 users (33%), and less than a quarter had more than 10,000 users (19%). Nearly half of users fell in between (48%), with many of them having greater than 100 but fewer than 5,000 users. The assessed platforms tended to have a modest level of partners, with most under 10. In a few cases, platforms had a much higher figure, although the coordination of such several partners through the platforms would require further research.
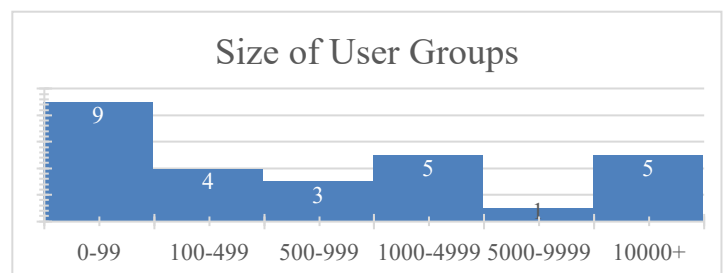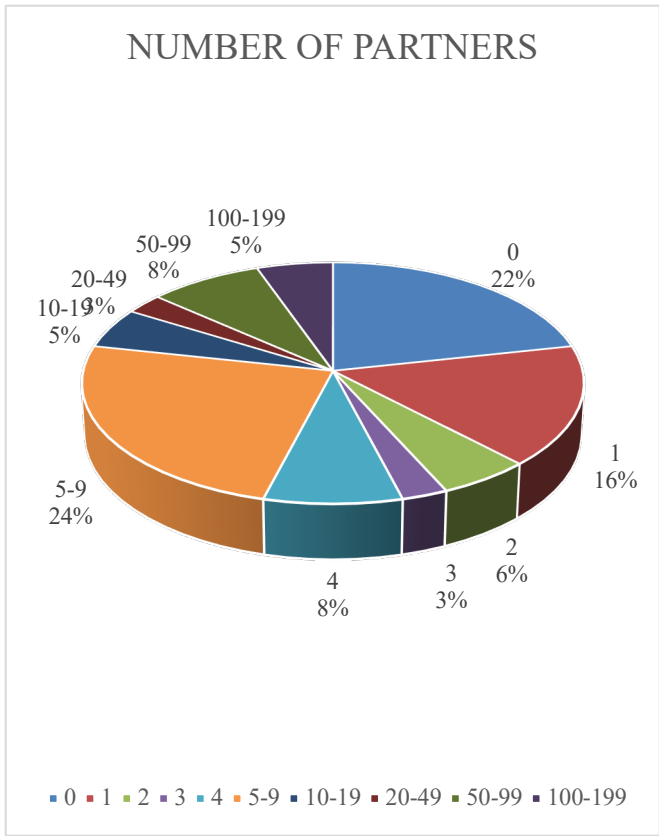
4.9 Target Users

Most of the platforms assessed were catering to different audiences, such as local government, civil society, and to a lesser extent private enterprise. Platforms for the local government audience (such as the IDB Cities Network and the European Sustainable Cities Platform), and those that represented several actor types (such as Acter and the Thriving Resilient Communities Collaboratory) both represented 33% of those assessed. Platforms representing non-profits and civil society were relatively scant in our sample and included Action for Sustainable Development and the Communities for Future Collaborate Platform. National government platforms accounted for a low proportion, which is explained by the fact 'local actors' were a target group of this study.

Size of User Groups

Bar chart showing size of user groups: 0-99: 9; 100-499: 4; 500-999: 3; 1000-4999: 5; 5000-9999: 1; 10000+: 5

NUMBER OF PARTNERS

0 — 22%
1 — 16%
2 — 6%
3 — 3%
4 — 8%
5-9 — 24%
10-19 — 5%
20-49 — 3%
50-99 — 8%
100-199 — 5%

Legend: 0 ▪ 1 ▪ 2 ▪ 3 ▪ 4 ▪ 5-9 ▪ 10-19 ▪ 20-49 ▪ 50-99 ▪ 100-199

4.11 Usability and governance

Within this category, the authors coded for whether end-users could log in (a pre-requisite for an online platform). The authors also coded for the type of governance of the platform which found that 62% had closed governance (with no participation), 21% had some formal mechanism to represent stakeholders and/or hold administrators to account, 14% had open/participatory governance, where users can participate in decision making; no other types of governance were noted.

4.12 Tools and features

The platforms reviewed had a multitude of tools in their toolkits. Nearly two-thirds of platforms had compendiums (71.4%), which we understood as catalogues of best practices, case summaries, policies, or other sustainability innovations. Over half of the platforms allowed users to create their own profiles (60%), and many allowed users to search for others in a directory (47%), engage in forums (60%), or message or chat with other users (33%). Less common were more advanced features, such as self-assessment tools; slightly over a third of platforms offered such a tool (38 %), which allowed users to calculate impact or progress on select sustainability goals. Indexing was also less common, with a little over a third of platforms

(38%) offering a tool that linked local sustainability indicators to higher-level targets or goals, such as national or global SDGs. Finally, about a quarter of platforms (29%) provided some sort of matching service, which connected users with resources for addressing their sustainability questions or issues.

Concerning usability, most platforms were only available in English (53%); whether the platform existed in English only or other languages indicates the presence of an Anglophone bias within the digital architecture of sustainability platforms, which suggests this may well be the case. Somewhat surprisingly, less than half offered users a guide for how to use their platform (41%). Additionally, fewer than half offered case studies that showcased the actual use of their platforms (41%), suggesting there is still scope to significantly scale up self-celebration within the array of sustainability platforms, particularly if they are to be geared towards action-orientated missions.

5 Discussion

While some platforms assessed provide instructive case studies many do not analyze deeper patterns or the theoretical fabric of how sustainability transitions occur. In addition, clearly the SDGs are an integral feature of many sustainability platforms which signals they are a stabilization of an institutionalized discourse. Relating to Strasser et al's (2019) 3D model, this demonstrates they are widespread, structurally embedded in the architecture of digital platforms and their increasing commonality suggests they have a long-term presence. This begs the question over the extent that the SDGs may crowd out, or complement, existing initiatives that purposefully (or not) may wish to decouple their actions from the SDGs.

The fact that one-third of the sample explicitly targeted entities based in the Global South suggests that there is still an inherent bias in trans-regional innovations, rather than a robust global peer-to-peer exchange on sustainability issues through digital platforms. We did not assess whether digital platforms are increasing additional capacities to engage in sustainable actions nor how these occur within and across different locales, which would require further research.

We suggest that a new level of cooperation and transdisciplinary knowledge is greatly needed. A global circuitry that facilitates the sharing of local innovations,

best practices and insights that is adaptable to unique local needs is vital. Future efforts on digital sustainability platforms should be context-sensitive and iterative, relating to local and global issues working within a platform concept to help surface challenges for adaptive urban governance, providing a much-needed mechanism for the global exchange of local innovations.

The transdisciplinary turn on digital innovation emphasizes the need for actionable knowledge that is co-created with the practitioners. Considering the enormous challenges and limited resources local leaders must work with, co-productive processes are necessary to generate new solutions to increasingly complex challenges and allow buried or promising latent practices to be bought to the surface. As such, co-design of sustainability platforms with end-users is vital. For instance, digital platforms that create networks of local actors across various stakeholders; government, business sectors and territories could bridge the gap between academic research and practitioners towards the SDGs and other common sustainability goals (see Kasuga, 2021).

A reciprocal and wide sharing of knowledge (including indigenous knowledges) could improve the availability and accessibility of climate information to local stakeholders and deepen insights on others' perspectives. Deepening integration of scholarship and practice through more easily interpretable research and greater connections with academics and 'local actors' can help share, adapt and customize solutions. This could advance both scientific understanding and local decision-making in climate governance, insights into sustainability transition pathways, and improved empirically-based system change models.

Researcher-practitioner knowledge sharing could 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 through the use of Artificial Intelligence (AI) that produces a comparability (best fit) score that allows users to confirm whether suggested indicators match, or if these should be modified based on organizational needs. Data fields between 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 anonymous and not flow through a global data chain).

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 in an appreciation of the human, normative aspects to sustainability data management (Asokan et al., 2020) and their relation to sustainability transition pathways. Thus, incorporating innovative computational methods, such as AI and Big Data, could predict correlations and trends, but only in so far as this is centered within a qualitative account of different user group perspectives and context-based accounts of how particular configurations affect localized or thematic eco-systems (see also Asokan et al., 2020).

An organizational readiness index could be developed to guide users seeking to create a platform to enhance their internal sustainability and integrate sustainability outcomes into their organizational design. Above all, we suggest that these efforts should not reinvent the wheel: much exists in terms of the offer of sustainability knowledge action platforms, what is needed is the interoperability of these different platforms through synergistic, federated processes – or 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 global and platform organization and governance affects digital transformation and learning ecosystems of transition of local-level sustainability action in different contexts. This would help assess the geography of the diffusion of 'sustainable' practices and approaches and the generation of new pathways, or trajectories, towards different sustainability modes. The correlation of actor and system characteristics can also provide insights into optimal organizational capacities and propensity towards 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. Future research in this area is needed to measure the impacts of the SDGs in encouraging 'building back better' in response to the Covid-19 pandemic and as it relates to placed-based specificity or generalizable trends and processes.

There could be potential to extend the offer of some platforms to cater to different audiences, such as local government and community actors, if there were greater synergies between data sources e.g., via an app. However, with this comes 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 data interoperability and integration could be managed differently if in the interests of the 'greater good' of sustainable futures. In addition, were there to be greater (financial or non-monetary) incentives to encourage the collection, disclosure, and sharing of data, these would necessarily need to promote trust and engagement in data governance, all of which are likely to differ across regions.

In addition, stakeholders with different interests and motivations could facilitate data sharing whereby engagement in a platform could be multiplied through a Regenerative Value (see Burnett, draft paper): a value generated only when other forms of capital (i.e., financial, material, social, human and natural) are used in sustainable ways. If an organization were found to be employing other forms of capital sustainably, it would earn Regenerative Value dividends, which it could invest in further sustainable programs within the platform ecosystem, such as investing in sustainability initiatives in the wider community, or donate to sustainability projects in developing countries.

6. Conclusion

This paper has presented research outlining a comparison on sustainability knowledge management solutions to highlight the potential for scoping opportunities and limitations of digital platforms as a mechanism for sustainable transformation. We found that while such platforms provide an array of resources, they lack trackability and synergy and many actions do not align local targets with international priorities. At present, while there has been significant investment in convening knowledge and actors to advance sustainability outcomes, each has limitations in terms of its potential to facilitate the widespread sharing and exchange of information, tools and frameworks to assist localities in identifying appropriate actions relevant to their particular context or needs; for instance, whether to implement an overarching sustainability agenda or to align with the Sustainable Development Goals (SDGs). Some online providers serve users at a national or regional level, others are addressed to a global audience, though rarely accommodating a diversity of languages. We suggest that a holistic and systemic sustainability knowledge action platform with an orchestrating architecture could encourage the scaling-up of sustainable solutions and offer the potential for wide-ranging indicator synthesis at different scales.

A worldwide assessment of the common definitions of sustainability among communities, local government, and the private sector, that includes the consideration of fundamental misconceptions between sectors occur is needed. We recommend further research to determine how data-driven innovation can become appropriately embedded in national and local knowledge management systems and what mechanisms would be required for a global platform to be effectively regulated while at the same time being a user-driven approach. Such an assessment would help determine whether sufficient incentives for actors to carry out shared sustainable behavior exist or if further incentives are needed to create systemic change. In addition, more detail on how incentives can be tailored to be suitable across different contexts and what a universal greening incentive might look like is required.

In conclusion, through the promotion of co-benefits, interconnectivity and adaptability among environmental, cultural and political contexts, an integrated digital platform could foster coordinated research, track efforts among diverse populations (including local actors disproportionally affected by climate change) and analyse local to global actions to ensure adequate policies in support of public and private sustainability actions.

We hope that this analysis serves as a foundation for designing more globally accessible, user-friendly, informative, comprehensive, and interactive platforms, particularly for those with the most transformative impacts at the municipal or community level.

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