



Friends or enemies? Unraveling niche-regime interactions in grassroots digital innovations

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ABSTRACT

During the COVID-19 pandemic, grassroots digital innovations (GDIs) have gained traction as innovation niches, providing an alternative to the prevailing mainstream regime dominating smart city transitions. Drawing upon interviews with experts and promoters of GDIs from 12 European countries, we explore the relationships between these initiatives and mainstream regime actors. Five distinct types of niche-regime interactions have emerged from the analysis: inertia, indirect support, antagonism, direct support, and active collaboration. These interactions do not follow a linear and incremental trajectory, but rather represent dynamic configurations that change over time and at different geographic scales. Consequently, our findings contribute to the literature on socio-technical transitions and grassroots innovation by further revealing the multidimensionality and multi-scalarity of mainstream regimes. In light of these findings, we urge scholars and practitioners to reconsider how information flows and power imbalances among local and supralocal actors in mainstream regimes influence the development of innovation niches and dictate the pace of socio-technical transitions.

1. Introduction

During the COVID-19 pandemic, cities worldwide have experienced a notable surge in the development of grassroots digital innovations (GDIs) (UNCTAD, 2021). GDIs are “community-led efforts [...] to meet people's needs by appropriating technological tools” (Vadiati, 2022, p. 6). They encompass various forms of innovation, such as e-commerce portals managed by consortia of local businesses (Fuster Morell and Espelt, 2018), digital platforms operated by cooperatives of workers (Grohmann, 2021), and smartphone applications created by local communities (Scholz and Schneider, 2016).

Scholars have portrayed these initiatives as alternative paradigms for the digital transformation of urban areas (Boni et al., 2019; Morozov and Bria, 2018; Vadiati, 2022). They contend that GDIs offer an opportunity to replace the corporate-led, techno-centric approaches currently dominating smart city transitions with bottom-up cooperative models that empower local communities to regain control over digital services and infrastructure (Mann et al., 2020; Mora et al., 2021; Trencher, 2019). It should be noted, however, that the viability of these initiatives still depends largely on the support they receive from the political and

market institutions they intend to challenge (Mann et al., 2020; Zhu and Marjanovic, 2021).

The relationship between grassroots innovations and mainstream institutions has been extensively debated in transition studies, especially through the lens of the multilevel perspective (MLP) on socio-technical systems (Geels, 2004). In this framework, grassroots initiatives are interpreted as innovation niches with the potential to transform or replace existing socio-technical regimes (Ng et al., 2022; Seyfang and Longhurst, 2013). This perspective aligns with the narrative underlying many GDIs as they often present themselves as radical alternatives to mainstream actors in smart city transitions (Morozov and Bria, 2018; Scholz and Schneider, 2016). Nevertheless, some critics question the otherness and radicality of these initiatives, viewing them as just another form of entrepreneurialism that permeates the neoliberal discourse on urban innovation (Papadimitropoulos, 2021; Sandoval, 2020).

The interactions between niches and regimes remain an opaque and undertheorized aspect of socio-technical transitions, deserving further empirical and theoretical investigation (Raven et al., 2012; Smink et al., 2015). Previous studies have shown that the boundaries between niches

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and regimes are generally less pronounced than predicted by MLP theory, calling for more research to unravel the complex and intricate nature of these interactions (Pekkarinen and Melkas, 2019; Ohta, 2019). Furthermore, additional analyses are required to elucidate the relationship between niche and regime actors at different spatial and scale levels, to fully uncover the complexity of the multilevel governance systems in which socio-technical transitions unfold (Binz et al., 2020; North and Longhurst, 2013).

This study contributes to these ongoing debates by addressing the following research question: How do niche-regime interactions at different geographic levels influence the development of grassroots digital innovation? The objectives are twofold. First, we aim to explore the types of interactions connecting niche and regime actors (Ng et al., 2022) using GDIs as our empirical context. Second, we seek to shed light on the multidimensional and multiscale nature of niche-regime interactions, by investigating how the multilevel governance of smart city transitions influences the development of GDIs (Binz et al., 2020; Wolfram, 2018).

Our analysis draws upon 36 semi-structured interviews with experts and promoters of GDIs from 12 European countries. Applying the methodological protocol developed by Gioia et al. (2012), we discovered that the relationships between mainstream regimes and grassroots niches can be classified into five types of interactions: Inertia, Indirect Support, Antagonism, Direct Support, and Active Collaboration. These typologies complement existing discussions on regime-niche interactions, revealing the often overlooked nonlinearity and instability of these relationships.

Our results show that niche-regime innovations may not follow a linear and unidirectional path. Moreover, they show that grassroots innovations interact with a multitude of incumbent regime actors situated at multiple geographic levels, exposing the multidimensionality and multiscalarity of regime-niche interactions. These findings have both theoretical and practical implications, as they encourage a reassessment of how actors in different regimes influence each other and how niche strategies need to be adapted accordingly.

The remainder of this paper is organized as follows. Section 2 reviews the MLP literature on interactions between socio-technical regimes and grassroots innovation niches. This review defines the theoretical framing for the analytical process, with the methodology outlined in Section 3. The findings of the study are presented in Section 4. Section 5 outlines the theoretical contributions and practical implications of our analysis, discusses its limitations, and provides recommendations for future research.

2. Theoretical framing

2.1. Grassroots innovation through the lens of MLP

The multilevel perspective (MLP) provides a conceptual framework that examines socio-technical transitions by considering the interplay of three different levels of analysis: Niches (micro-level), Regimes (meso-level), and Landscapes (macro-level) (Geels, 2004). A socio-technical regime comprises institutionalized rules and beliefs that guide actors operating in a specific socio-technical system. Niches are protected “sites where alternatives try to resolve regime contradictions” (Seyfang and Smith, 2007, p. 589) through the experimentation of emerging socio-technical innovations. Both niches and regimes are influenced by landscape forces, which encompass the broader socio-technical context and structural trends operating at the macro level (Geels, 2004, 2019).

In the academic literature, grassroots innovations are characterized as a unique category of socio-technical niches. They are designated spaces “of values and culture rather than market pressures” (Seyfang and Haxeltine, 2012, p. 384), where innovation is primarily driven by ideological motives rather than radical technological advancements (Witkamp et al., 2011; Dana et al., 2021). Scholars agree that grassroots innovations do not exhibit the typical growth objectives associated with

socio-technical niches (Seyfang and Longhurst, 2013). Grassroots innovations are not necessarily conceived to replace an existing regime; instead, they seek to develop as a parallel system, coexisting with the mainstream ones (Hargreaves et al., 2013; Seyfang and Smith, 2007).

2.2. The relationships between regime actors and grassroots innovations in socio-technical transitions

The relationship between niches and regimes is central to socio-technical transitions (Smink et al., 2015). The MLP theory assumes that actors in the mainstream regime may, in the initial stage, exhibit reluctance toward embracing niche innovations. This hesitance stems from their aversion to risk and preference to uphold the existing status quo (Seyfang and Haxeltine, 2012; Smith et al., 2005). However, as their understanding of innovation niches deepens and they learn more about their inherent value (Geels and Deuten, 2006), regime actors may change their responses. Eventually, they are expected to endorse and integrate grassroots innovations (Ng et al., 2022; Dana et al., 2021).

Previous research has shown that this process is often facilitated by regime-based intermediaries (Kivimaa et al., 2019). These intermediaries, which can include universities, nongovernmental organizations, and government agencies, are intentionally established to champion socio-technical transitions (Boyle et al., 2021). Despite their affiliation with the dominant regime, they are open to niche ideas due to their mission or mandate to support transformative change (Kivimaa et al., 2019; Diaz et al., 2013). Regime-based intermediaries thus act as a liaison between the micro and meso levels by facilitating knowledge exchanges on grassroots innovations and by fostering partnerships between niche and regime actors (Wolf et al., 2021).

The emphasis on knowledge accumulation, learning processes, and the role of regime-based intermediaries reflects the tendency of transition scholars to perceive niche-regime interactions as linear and evolutionary processes guided by rational considerations (Pekkarinen and Melkas, 2019). However, this viewpoint is increasingly challenged by researchers who frame socio-technical transitions as “a complex and often messy process” (Diaz et al., 2013, p. 63). According to this perspective, the relationships between niche and regime actors are not primarily guided by rational motives but are also shaped by contingent factors at the micro level, tensions at the meso level, and landscape pressures exerted by the macro level (Smink et al., 2015; Avelino and Rotmans, 2009).

Consequently, there is a growing need for further research on niche-regime interactions to clarify why and how these relationships between innovation niches and incumbent actors evolve over time and in different geographic contexts (Diaz et al., 2013; Pekkarinen and Melkas, 2019). This article contributes to this ongoing debate by examining the interplay between mainstream actors and GDIs in the context of digital transitions. This empirical setting is relatively unexplored in the literature on grassroots innovation and socio-technical transitions. Given the unique nature of these initiatives and their integration into multi-level governance systems (Mora et al., 2023; Vadiati, 2022), focusing on GDIs provides valuable insights into the spatial characteristics and dynamics underlying socio-technical transition processes.

2.3. Space and scale in niche-regime interactions

Transition studies have been increasingly criticized for their lack of spatial sensitivity (Chandrasekaran, 2016) and for their tendency to overlook the importance of scale and space in socio-technical transitions (Boyer, 2015). This criticism underscores the propensity of transition scholars to implicitly assume the spatial scale of MLP levels (Raven et al., 2012) without fully unraveling the intricate multi-level governance systems within which socio-technical transitions unfold (Binz et al., 2020; North and Longhurst, 2013).

Efforts have been made to address this theoretical gap by emphasizing the role of local resources and transnational networks in shaping

niche formation and transition processes (Hodson and Marvin, 2010; Raven et al., 2012; Lai, 2023). Previous research has emphasized the importance of urban environments as testbeds for innovation niches and catalysts for grassroots innovation. Urban environments “provide protected spaces that allow people to articulate and enact [...] ‘alternative ontologies’ and ‘spatial imaginaries’ of socio-technical change” (Wolfram, 2018, p. 12).

However, these studies focus predominantly on the micro-level, shedding light on the circumstances under which innovation niches develop and diffuse, but do not provide a comprehensive overview of the interactions between local and supralocal actors across MLP levels and within each of them. In this article, we seek to address this gap in the extant literature by delving into the multiple and complex interactions that exist between grassroots niches and regime actors at various geographic levels (Chandrashekeran, 2016). By centering our analysis on GDIs, we also seek to extend the study of niche-regime interactions in an empirical setting distinct from sustainable transitions, offering novel empirical insights into the multidimensionality and multiscale nature of socio-technical regimes (Binz et al., 2020).

3. Methodology

Drawing upon this theoretical background, we adopted an inductive qualitative approach to address a fundamental research question: *how do niche-regime interactions at different geographic levels influence grassroots innovation?* Our analysis focuses on GDI initiatives across Europe, which offer a data-rich and meaningful empirical setting to explore the intricacies of niche-regime interactions across spatial scales (Sandoval, 2020; Scholz and Schneider, 2016). These initiatives, which originate from the bottom-up, are deeply rooted in specific urban or regional contexts (Boni et al., 2019). However, as providers of digital services and platforms, they compete with multinational corporations that dominate the global information and communication technology market (Morozov and Bria, 2018) and are subject to laws and regulations established by national and international policymakers (Mora et al., 2023).

Our data collection strategy was based on purposive sampling, bolstered by snowball sampling techniques (Campbell et al., 2020; Kirchherr and Charles, 2018). This approach allowed us to consider the wide range of geographic and sectoral areas in which GDIs operate, spanning 12 European countries (Belgium, Croatia, France, Germany, Ireland, Italy, the Netherlands, North Macedonia, Poland, Spain, Switzerland, and the United Kingdom) and eight sectors (creative industries, CivTech,¹ education, food, healthcare, mobility, information technology, and tourism).

The countries and sectors included in our sample have different levels of GDIs' diffusion and development. For instance, grassroots innovations are well documented in the food delivery and tourism sectors (Acquier et al., 2017; Mannan and Pek, 2023). In contrast, GDIs in sectors such as healthcare and education are more recent initiatives (Calzada, 2023). Similarly, countries such as Spain and Italy have a long history of community-led innovation and cooperative organizations (Evans and Meade, 2006), while in countries such as Poland and Croatia, the third sector is less developed (Salamon and Sokolowski, 2018). Moreover, the countries in the sample show different levels of adoption and acceptance of digital technologies (European Commission, 2022).

This heterogeneity, which was embedded in the data collection process, helped to increase the representativeness of our sample, and thus improve the validity of our study (Leung, 2015; Rose and Johnson, 2020). Furthermore, focusing our empirical analysis on European GDIs allows for meaningful data comparisons, which strengthens the reliability and generalizability of our findings (Leung, 2015; Sinkovics et al., 2008).

In addition, our analysis included grassroots initiatives at different

stages of development; some have been operating for over 15 years, while others were established more recently, even during the COVID-19 crisis. This combination allowed us to examine niche-regime interactions over time and to avoid the limitation of focusing only on the early stages of niche development, a recognized shortcoming in transition studies (Sovacool et al., 2020). Our sample also includes GDIs that have ceased operations, as considering unsuccessful initiatives is critical to gaining deeper insights into the factors that contribute to the success of grassroots niches (Dana et al., 2021).

A total of 115 experts were invited to participate in the semi-structured interviews, of whom 36 agreed to participate. The interviewees can be divided into two categories. First, founders and employees of grassroots organizations were carefully selected from relevant cases reported in secondary sources. The public repository provided by the Platform Cooperativism Consortium is an example of such a source.² Second, we interviewed representatives of the cooperative movement, researchers, consultants, and public sector officials with expertise in GDIs. These interviewees were identified through an extensive review of press articles, advisory reports, and other gray literature examining the development of GDIs in Europe.

Interviews lasted between 36 and 90 min, with an average duration of 55 min (see Appendix 1) and were conducted face-to-face or online. All interviews were recorded, automatically transcribed using speech-to-text technology, and manually reviewed to ensure content quality. Subsequently, the transcripts were analyzed with NVIVO using the thematic coding approach proposed by Gioia et al. (2012). Initially, we examined the interview data and identified 452 excerpts describing regime actors' actions and attitudes when interacting with GDIs (see Appendix 2). Coding these excerpts resulted in 32 concepts (first-level coding) that were grouped into 12 themes (second-level coding). These themes were grouped into five theoretical dimensions that emerged inductively from the data (see Section 2). The final data structure was validated through several iterations of coding and discussions within the research team (Table 1).

4. Findings

Our data have shown that GDIs lie at the intersection of digital and grassroots innovations. This positioning endows them with the capability to act as innovation niches and exert two distinct forms of pressure on mainstream regimes. First, GDIs actively promote the digital transformation of their respective sectors by introducing innovations based on technological advancements. Second, they advocate for change in the market of smart city solutions, by proposing bottom-up and participatory models for the governance of data and digital platforms.

The interviews also shed light on the wide variety of local and supralocal regime actors with whom European GDIs engage. At the local level, they often interact with municipal governments, local businesses, representatives of citizen groups, regional universities, regional development agencies, and nonprofit or cooperative organizations that operate locally. Among supralocal actors, GDIs most often interact with national or EU regulatory agencies, national cooperative associations, national credit unions, EU-wide funding programs supporting social enterprises, and multinational technology providers.

However, our analysis shows that the interaction of regime actors with GDIs is not static but tends to mutate over time. These interactions can be classified into five categories: Inertia, Indirect Support, Antagonism, Direct Support, and Active Collaboration. Each category is associated with one of the theoretical dimensions inherent to our data structure. These dimensions are discussed in more detail in the following subsections.

¹ Digital technologies for public participation and civic engagement.

² <https://directory.platform.coop/#1/31.1/-84.8>

Table 1
Data structure.

Concepts First-level coding	Themes Second-level coding	Aggregate dimensions Third-level coding
Lack of awareness on GDIs among supralocal policymakers	Lack of awareness on grassroots innovation models	Inertia
Lack of awareness on GDIs among local actors		
Resistance to digital innovation among local actors	Resistance to digital innovation	
Resistance to digital innovation in the third sector		
Public subsidies for SMEs and start-ups	Generic support for innovative organizations	
Training and incubation programs		
Local tradition of grassroots organizations	Awareness on the potential of grassroots innovations	Indirect support
Interest of local governments toward grassroots innovations		
Awareness of local actors on the opportunities of digital technologies	Market hostility	Antagonism
Awareness of local actors on the socio-technical issues addressed by GDIs		
Awareness of supralocal regulators on the value of GDIs	Political hostility	
Incumbent firms exerting their market power		
Hostility of financial investors	Awareness raising	
Hostility of local politicians toward GDIs		
Supralocal regulations hostile to GDIs	Financial support	Direct support
Local authorities giving visibility to GDIs		
Local businesses giving visibility to GDIs	Adoption of grassroots innovations	
Third sector organizations giving visibility to GDIs		
Funding from local administrations	Political support	
Funding from supralocal administrations		
Funding from third sector organizations	Co-founding of grassroots organizations	Active collaboration
Local administrations using the services of GDIs		
Local businesses using the services of GDIs	Co-design of grassroots innovations	
Supralocal businesses using the services of GDIs		
Third Sector organizations using the services of GDIs		
Regulatory support		
Promotion and coordination of GDIs at the translocal level		
Research institutions as co-founders of GDIs		
Third sector organizations as co-founders of GDIs		
Partnerships in research programs		
Co-design of innovation with local administrations		
Co-design of innovation with local businesses		

4.1. Inertia

Inertia describes the attitudes and behaviors of regime actors who refrain from engaging in any action, whether in favor of or in opposition to GDIs. The interviewees clarified that this absence of reaction can be attributed to the resistance of incumbent actors toward embracing digital innovation or their limited understanding of grassroots innovation

models.

4.1.1. Resistance to digital innovation

Resistance to digital innovation manifested throughout the data sample, among both local and supralocal regime actors. Local governments and local businesses tend to show limited interest in digital innovation unless they are “aware of technology as a potentially empowering tool” (I.04). Consequently, they often “struggle to change and innovate” (I.25). This attitude is similarly observed among cooperatives and other organizations operating within the third sector, which have been “late in seizing the opportunities deriving from new technologies” (I.05).

The reluctance of these regime actors to embrace digital innovation and endorse GDIs is rooted in their low levels of digital literacy and fundamental lack of trust in digital technologies. Interviewees have noted that “the platform economy is still very scary for some” (I.02), particularly in the third sector where incumbent organizations “sometimes do not have a positive perspective about digitalization” (I.13). In this context, “technology is seen as something to be scared of” (I.26). Additionally, many traditional cooperatives have approached GDIs with skepticism because their operational model, by “emulating that of digital start-ups, is seen as incompatible with the values and ethos of the cooperative movement” (I.25).

4.1.2. Lack of awareness on grassroots innovation models

Another explanation for the inertia of mainstream actors lies in their limited familiarity with grassroots innovation models. The modest scope and reach of these initiatives, coupled with the absence of widely recognized and successful cases, leads to a situation in which GDIs remain outside “the radar of politicians” (I.04). Therefore, participants from Italy, the United Kingdom (UK), and Germany have described local governments as entities that are often unwilling and incapable to propose measures that “are designed to support the [innovation] approach of grassroots initiatives” (I.08).

Interviewees from Germany, Croatia, and the Netherlands have also pointed out that “people are not used to this kind of organizations” (I.06), primarily because of the scarcity of cooperatives and other social enterprises at the national level. Consequently, it becomes difficult for GDIs to establish themselves as legitimate players within the mainstream regime: if “the average person does not know what they are, they do not understand what the point of them is” (I.23).

Moreover, in all the countries included in the sample, the lack of awareness is closely connected to the fact that “schools and universities do not really teach about cooperatives” (I.04). This limited consideration for grassroots initiatives within mainstream education programs contributes to reducing the visibility of GDIs and constrains their ability to attract information technology professionals. This happens because “most tech people never hear of [GDIs], they just know about the standard start-up model” (I.23).

4.2. Indirect support

Even without implementing actions explicitly intended to support grassroots innovations, regime actors might still offer socio-technical arrangements favorable to GDI development. The *indirect support* of regimes has been observed at both the local and supralocal levels and manifested when mainstream actors were supportive of innovation and aware of the potential of grassroots initiatives.

4.2.1. Generic support for innovation

The interviews shed light on how GDIs operating in creative industries, information technology development, and urban mobility have benefited from measures introduced by local and national governments. These measures aimed to promote the creation of digital businesses and the digital transformation of small and medium enterprises. Examples provided by the interviewees included subsidies directed at digital start-

ups, fiscal deductions for investments in digital technologies, incubation programs, and access to “Living Labs to build and test new products and services” (I.02).

These measures partially compensate for the lack of dedicated funding schemes specifically targeting GDIs. However, the bureaucratic hurdles associated with these support measures remain a major challenge. Grassroots organizations often cannot meet the legal and formal requirements imposed by local and national funding agencies. An employee of a platform cooperative in Italy shared an illustrative example: “It took us two years to receive these fiscal subsidies because our activities were not recognized in the general classification of economic activities used by the government” (I.10).

4.2.2. Awareness on the potential of grassroots innovation

Our findings also suggest that GDIs thrive in local contexts where regime actors are aware of the societal challenges that trigger grassroots movements and share their values and concerns to some extent. This trend seems to be more prevalent in urban areas with “historical traditions about cooperatives and a social structure [...] and culture” that are supportive of bottom-up and citizen-driven initiatives (I.13).

However, even in countries where this cultural backdrop and traditions are less widespread and not firmly entrenched, interviewees reported an increasing interest in GDIs since the onset of the COVID-19 pandemic. The restrictions introduced to contain the spread of the virus have impelled individuals and businesses to embrace new digital innovations, providing “the average person [with] a lot of experience [...] of [how] a digitalized society [...] look like” (I.22). This heightened awareness of the opportunities provided by digital technologies has motivated an increasing number of regime actors to experiment with alternative digital platforms and services. As one interviewee explained, “people want to be more independent from the big companies and to have more data protection” (I.19).

A similar attitude toward GDIs has recently emerged within public sector organizations at various geographic levels. Experts in our study have observed that, throughout Europe, local politicians and civil servants overseeing digitization programs have become more “open and interested in the cooperative approach” (I.08). Similarly, EU legislators and other international institutions, such as the International Labour Organization (ILO) and the World Bank, have begun to acknowledge that “cooperatives can be a tool to enhance equality and give more power to workers and users” (I.05), although they still need to “find ways to effectively support these initiatives” (I.05).

4.3. Antagonism

Antagonism refers to the interactions that regime actors initiate to hinder the progress of GDIs. In this regard, it is important to note that an increased awareness on grassroots innovation does not always lead regime actors to endorse and support these initiatives. Instead, our data reveals that incumbent actors may actively resist the growth of grassroots niches through strategies involving market hostility or political hostility.

4.3.1. Market hostility

The interviewees often compared the interaction between GDIs and incumbent business organizations to the “rivalry between David and Goliath” (I.14). The small scale of grassroots organizations was perceived as initially affording them protection from the reactions of larger competitors. As emphasized by a member of a German platform cooperative operating in the food sector: “we are way too small, we are not interesting for big companies” (I.20). Nonetheless, participants from Germany and Italy reported that certain information technology corporations and ride-hailing platforms have “tried to lock in their users” (I.19), either through imposing exclusive agreements that “force their customers to interrupt any relationship with other platforms” (I.14) or by establishing technical conditions that restrict the interoperability of

mainstream commercial services with GDIs.

More often, GDIs have experienced hostility from financial investors who have traditionally backed digital startups. Interviewees complained that these actors are unlikely to support GDIs because the ethos and goals of these initiatives typically misalign with the values and expectations of venture capitalists and other mainstream investors. In addition, grassroots organizations generally adopt governance models that prevent majority shareholders from gaining control. As a result, “venture capital will not touch co-operatives, because they will not be able to buy 50% of the assets” (I.23).

4.3.2. Political hostility

Across the countries in our sample, GDIs have also met resistance from politicians and policymakers, at both the local and supralocal levels. A partial explanation for this hostile attitude lies in the fact that grassroots innovations “are often perceived as associated with fringe radical political movements” (I.04). Therefore, they face resistance from politicians who do not share the same ideological orientation. Additionally, some local administrations are unwilling to support GDIs because their leaders “are openly pro-big tech corporations” (I.34).

A similar attitude has been noted among legislators at the national and EU levels, whose regulations have been criticized for favoring mainstream technological providers over local alternative solutions. As pointed out by the founder of a platform cooperative in France: “open source is not even something they think about” (I.15). Our interviewees also concurred that it remains difficult for GDIs to compete successfully in public procurement processes because “the dimensions of public contracts are always too large” (I.34) for small grassroots organizations. Moreover, national regulations on public spending inevitably encourage local authorities to “go for one of the big corporations that can cut costs [...] rather than a small coop that might cost them a bit more” (I.18).

4.4. Direct support

Direct support encompasses various deliberate actions undertaken by regime actors to actively promote GDIs. These contributions take a variety of forms, including raising awareness, providing financial support, adopting grassroots innovation, and providing political support. Importantly, direct support was observed at different geographic levels.

4.4.1. Awareness-raising

In some instances, municipal governments have taken proactive steps to support grassroots initiatives to attract members, customers, and suppliers. This support involves “reaching out to businesses” (I.03) and promoting GDIs to other local administrations. Similarly, it was highlighted that local businesses and trade associations can act as intermediaries, bridging the gap between local communities and grassroots organizations, which “rely on them not just as a source of information, but also to take the information out” (I.24).

On a broader scale, nationwide third-sector organizations in Italy and the UK were also found to contribute to expanding the visibility of GDIs through various means. Examples include newsletters, public events, and other engagement mechanisms involving the local and national media. In addition, national and international cooperative movements have played a pivotal role in providing training opportunities that aim to “raise awareness on the necessity for social enterprises to embrace digital transformation” (I.05) and assist grassroots actors in assembling their skillsets and customer bases.

Efforts to raise awareness on GDIs transcend the mere expansion of their visibility among potential customers and business partners. Endorsement from influential regime actors with “power, authority, and profile” (I.03) also helps these initiatives “obtain validation from the local to the national level” (I.02) and attract financial investors. As emphasized by an activist from the UK cooperative movement: “once they get visibility and customers, it is much easier to get the funding” (I.04).

4.4.2. Financial support

Our data show that some GDIs have received funding from local administrations, supralocal governments, and national cooperative organizations. The latter have been instrumental in providing financial support through grants and acceleration programs specifically designed to aid grassroots innovation. However, these interventions are limited in number and scope. GDIs often receive loans from credit unions and other financial institutions promoting social enterprises. In some cases, cooperative banks “have even become shareholders, acting as financial members of the platform coop” (I.01). Alternatively, they have offered match funding for “every new member acquiring quotas in the capital” (I.10) of GDIs.

Grassroots initiatives with a focus on urban mobility, sustainable tourism, and sustainable food supply chains have also received public grants, mainly from local and regional authorities. Interviewees from Spain and the United Kingdom, for example, remarked that GDI initiatives might get “nothing from the central government” (I.09). Still, city councils have actively supported them through “a business development support program [...] and grants to local platform cooperatives” (I.18). In contrast, experts from Italy and Germany emphasized the role of regional authorities; in both countries, some regional authorities, “also for political reasons, offer funds to grassroots initiatives” (I.25).

4.4.3. Adoption of grassroots innovations

Regime actors also lend support to GDIs by embracing their services and becoming their customers. Several interviewees have noted the growing trend of third-sector organizations increasingly relying on applications and platforms offered by grassroots initiatives: “they are interested in developing this kind of solutions but do not have the resources to do it” (I.31). Moreover, technology and data cooperatives “tend to do most of their work for other cooperatives and social enterprises” (I.23).

Furthermore, our findings suggest that GDI promoters are increasingly seeking commercial agreements with business networks and trade associations, although the prevalence of this activity varies by sector. For example, grassroots organizations developing ride-hailing applications often work with local cab drivers and partner with national companies that provide complementary mobility services. Similarly, in France, Germany, and Switzerland, bottom-up platforms for food producers are joining forces with “different partner organizations, some national and some regional, [...] on the logistics of local food systems” (I.28).

Finally, our interviewees also expressed a consensus that “the most straightforward support is when [...] the city buys services from cooperatives rather than private companies” (I.04). Despite the challenges that grassroots initiatives across Europe face in complying with procurement regulations, some have “been successful at winning contracts” (I.18), but mainly where “the mayor is pro cooperatives” (I.23). Our participants frequently mentioned that the potential game-changer for GDIs lies in new procurement regulations that prioritize open-source technologies and locally sourced products. Examples of these regulations are currently being discussed in various European countries, including France, Switzerland, and Spain.

4.4.4. Political support

In addition to public procurement and public subsidies, local and supralocal governments can support GDIs through regulatory measures and political actions. Interviewees agreed that regulators at various administrative levels have recently become more sympathetic to grassroots organizations. For instance, “some national governments have started prohibiting the use of Google and Microsoft in public schools, following the recommendations of Data Protection Agencies” (I.34). Recent EU regulations also explicitly reference platform cooperatives and data cooperatives, a point emphasized by many experts in our sample.

In some countries, such as Belgium and Italy, the growing regulatory

support is further evidenced by the increasing involvement of grassroots organizations in policymaking processes “at the different levels of the administration” (I.16). Our data shows that GDI actors can be invited by municipal and national governments to participate in “working groups and committees in charge of generating innovate policies” (I.01). Some of these grassroots organizations have even been hired as consultants by local governments, “especially those that are very small and want to restart their local economies” (I.11).

Moreover, in several European countries, local governments and national agencies have been noted for their proactive attempts to “coordinate grassroots efforts” (I.08), especially in mobility services. National governments in Spain and Italy have recently promoted the formation of networks comprising local mobility providers to facilitate “the integration of different means of transportation in a single platform” (I.02). Meanwhile, local authorities in Germany and Spain are collaborating to harmonize their overarching initiatives in support of GDIs and “create an agreement about the type of public policies that they want to promote a fair platform economy development” (I.13).

4.5. Active collaboration

Active collaboration occurs when incumbents do not just provide external support but actively engage in the different stages of GDI development. Our data highlight that regime actors can even be co-founders or co-designers of GDIs.

4.5.1. Co-founding of grassroots organizations

Throughout Europe, numerous GDIs “stand on the shoulders of giants” (I.12), as their founders include well-established organizations that have long operated in the third sector. For example, in Italy and Belgium, platform cooperatives catering to freelance workers trace their roots back to cooperatives established in the 1990s. Similarly, “the majority of the car sharing cooperatives in Europe are close to citizen energy cooperatives” (I.09).

In some countries, international nongovernmental organizations (NGOs) have also been involved in the establishment of GDIs. For example, the Open Food Network (OFN) in Belgium was founded by the international charity Oxfam. As captured in our interview data, Oxfam “was working in the agriculture and agroecology sectors, and OFN offered the opportunity [...] to develop short food systems [...]. So, it was a perfect match” (I.35).

Additional regime actors frequently involved in the launch of GDIs are universities and other research institutions. The interviewees revealed that in some countries, such as Germany and Switzerland, grassroots initiatives have been instigated by “researchers and facilitators that [...] have worked in and around social problems” (I.29). In other countries, such as Italy and Spain, some GDIs have evolved from research projects focused on the development of digital solutions to sustainability challenges, effectively functioning as spinoffs for these academic endeavors.

4.5.2. Co-design of grassroots innovations

Collaboration with universities extends beyond the start-up phase of GDIs. As highlighted by our experts, the promoters of GDIs can “have a lot of partnerships with academics” (I.16) and actively engage in research projects. Based on our findings, these collaborations serve a dual purpose; they can contribute to refining the design of grassroots innovations, while also providing “resources for the development of these projects” (I.13), including the financial support necessary to sustain “grassroots organizations in the midterm” (I.21).

Moreover, GDI actors frequently establish partnerships with companies “who are in similar fields and have some complimentary services” (I.08). These partners typically share similar values and ethos. For example, when GDI initiatives are led by individuals with no background in information technology, they typically rely on open-source software developers to build digital platforms and applications.

Interestingly, some grassroots organizations even choose to collaborate with their competitors, as some interviewees noted. For instance, a platform cooperative supporting food producers in France is working with other cooperatives and “private companies that do not have many relationships with the open-source movement” (I.15). The partnership aims to ensure interoperability among these platforms.

The interview data also revealed that some GDIs have been “developed through close cooperation or communication with municipal officials” (I.33). According to our experts, this trend is particularly prominent when grassroots innovations focus on digital technology for public participation and civic engagement. The main driver seems to be the action of national governments, which have allocated “specific funding for local governments to look at opportunities to digitize existing processes” (I.07). Similarly, an Italian platform cooperative has recently partnered with a local council “to develop the technology for the collection of tourist taxes” (I.01).

5. Discussion

Our findings shed light on the intricate dynamics of the multiscale niche-regime relationships involving GDIs. These grassroots initiatives interact simultaneously with multiple regime actors operating at different geographic levels. As illustrated in Fig. 1, our analysis reveals five types of niche-regime interactions, which we classified based on two key attributes: the level of support that regime actors provide to grassroots initiatives and how these actors engage with niche development.

In line with MLP theory (Geels, 2019), the responses of regime actors to GDIs fluctuate between resistance and acceptance. Resistance inevitably implies a lack of engagement with niche development, whereas incumbent actors' involvement in the formation and growth of GDIs can intensify as their acceptance of grassroots innovations increases. Consequently, we observe a situation in which incumbent actors are indifferent to GDIs, and this lack of interest is characterized by the emergence of *inertia* or *indirect support*. In the latter case, regime actors contribute to the development of GDI initiatives by implementing generic measures that offer external support to innovation efforts and helping to create a sociocultural climate conducive to grassroots organizations. Likewise, incumbent actors who accept grassroots innovations may either promote GDI niches without participating in their creation (*direct support*) or be directly involved in the formation and development stages (*active collaboration*).

Our analysis has helped to provide a more comprehensive categorization of the interactions between niche and regime actors. The theoretical and practical implications of our findings are discussed in the following sections, followed by a brief discussion of the limitations of our study and recommendations for future research.

5.1. Theoretical implications

This study has three major theoretical implications. First, it advances

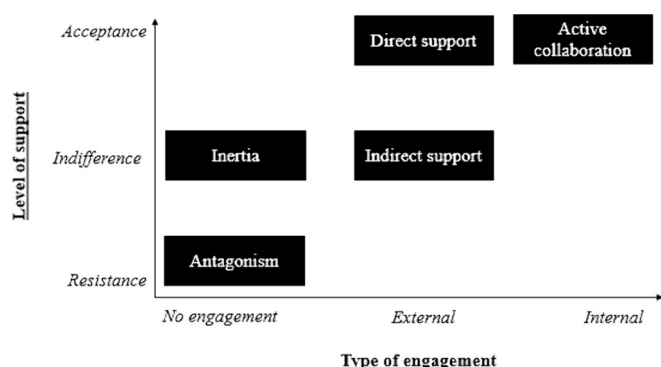


Fig. 1. Types of interactions between GDIs and regime actors.

our understanding of niche-regime interactions by extending existing taxonomies. Our findings also show that the relationships between grassroots niches and incumbent actors are not simply linear or static but change over time and vary at different geographic scales (Pekkarinen and Melkas, 2019; Ohta, 2019). Second, this study offers preliminary insights into the factors that influence niche-regime interactions (Binz et al., 2020; Chandrashekeran, 2016). Third, it delves into the multiscale nature of socio-technical regimes, helping to shed light on the information flows and power dynamics among incumbent actors positioned at different geographic levels (Avelino and Rotmans, 2009).

5.1.1. Non-linear and dynamic niche-regime interaction typologies

We contribute to the literature on socio-technical transitions and grassroots innovations by providing a more comprehensive overview and categorization of niche-regime interactions. In addition to the three levels of intervention – *inertia*, *indirect support*, and *direct support* – identified by Ng et al. (2022), our observations revealed two additional types of interactions: *antagonism* and *active collaboration*. Both these interactions emphasize the proactivity of incumbent actors, which is a departure from previous studies that tend to portray them “as locked-in and inert” (Geels, 2014, p. 35).

Accordingly, we propose a classification system for niche regime interactions based on two attributes (see Fig. 1): the level of regime support for innovation niches and the extent to which regime actors engage with niche development. This approach better captures the complexity of niche-regime interactions. Rather than simply describing the extent to which incumbent governments are receptive to innovation niches (Geels, 2014, 2019), our categorization also exposes the degree to which regime actors directly involve themselves in grassroots initiatives to support their development (Dutt, 2022).

Previous studies have described socio-technical transitions involving grassroots innovations as gradual transformation processes. These processes comprise predefined phases unfolding in a linear progression (Ng et al., 2022) and culminate in either the rejection or integration of niche innovations into the existing regime (Geels, 2004). However, the niche-regime interactions that emerge from our analysis suggest that GDI transition processes should not be interpreted as a sequence of linear and incremental steps. These interactions embody the dynamic nature of transitions; they represent configurations that undergo multiple changes throughout a socio-technical transition following irregular patterns (Diaz et al., 2013). Incumbent actors who initially antagonize grassroots innovations, for instance, may later offer direct support to these initiatives. Conversely, grassroots innovations that are co-created with incumbent actors may eventually lose the backing of the established regime. Drawing from this evidence, we join Pekkarinen and Melkas (2019) in challenging prevailing conceptualizations that overemphasize the evolutionary nature of niche-regime interactions, which tend to exhibit nonlinear patterns influenced by a multitude of factors.

5.1.2. Macro- and meso-level factors shaping niche-regime interactions

Examining our findings within the framework of socio-technical transition theories, we can identify three main factors that determine the nonlinearity and instability of niche-regime interactions: landscape pressures, information flows among incumbent actors, and the values and traditions existing within the regime. In this regard, our study contributes to addressing a theoretical gap in the MLP literature, which focuses mainly on the drivers of niche formation and development, with limited consideration to the factors underlying regime responses (Geels, 2019).

The recent COVID-19 pandemic is a compelling example of how the intensity and timing of landscape pressures influence the duration and direction of regime responses (Nwanekezie et al., 2021). Our data showed that the pandemic destabilized the regime and created an opening for the emergence of grassroots alternatives (Sheikh and Wu, 2023). These alternatives were quickly endorsed, adopted, and absorbed by mainstream regime actors. Nevertheless, in some cases, support from

the incumbents waned after the health emergency subsided. In line with Geels (2019), the mere existence of windows of opportunity was insufficient for innovation niches to grow and spread. Our study further deepens our understanding of this dynamic by showing that landscape pressures can lead incumbent actors to embrace innovation niches, but only temporarily until the status quo is restored.

Our findings also highlight the influence of information flows on niche-regime interactions. Consistent with Ng et al. (2022), they suggest that the dissemination of information about grassroots innovations encourages incumbent actors to move from an initial inert state to more supportive interactions. This finding is consistent with the transition literature, which emphasizes the central role of intermediaries and knowledge exchanges in supporting the formation of niches and their integration into socio-technical regimes (Kivimaa et al., 2019; Wolf et al., 2021). Raising awareness of the potential benefits of grassroots innovations is critical to increase their acceptance among incumbent actors, although this could also trigger antagonistic reactions if they are perceived as a credible threat to the status quo.

However, the interactions between niches and regimes are not only driven by utilitarian and rational considerations based on objective information. Our data also confirm that local cultures, existing traditions, and shared values contribute to shaping how innovation niches are perceived within socio-technical regimes and explain why some geographic contexts are more conducive to grassroots innovations (Wolfram, 2018; Hodson and Marvin, 2010). As our data show, incumbent actors are more likely to support grassroots initiatives when they share the same political values and societal concerns. This finding is consistent with previous research that emphasizes the important role of political and cultural influences in the development and diffusion of innovation niches (Seyfang and Smith, 2007; Raven et al., 2012).

It is important to recognize that the values and causes endorsed by grassroots initiatives may not align with the core beliefs of regime actors (Markard et al., 2016). In addition, ideological and cultural factors may be linked to macro-level trends in the landscape that are beyond the control of the regime (Geels, 2019). Consequently, our findings suggest that grassroots niches may lose support from incumbent actors over time if their underlying principles are no longer championed by the regime. This divergence further exacerbates the instability and nonlinearity of niche-regime interactions.

Therefore, our study contributes to a more nuanced understanding of how niche-regime interactions change over time (Pekkarinen and Melkas, 2019). Nevertheless, further research is needed to provide a comprehensive view of how landscape pressures and meso-level factors jointly influence incumbents' responses to grassroots niches. Particular attention should be paid to the influence exerted by the macro level on information dissemination, values, and traditions within the meso level (Markard et al., 2016). This consideration should encompass the multiple spatial scales and geographic levels that characterize mainstream regimes.

5.1.3. Information flows and power dynamics in multiscale regimes

Our findings underscore the multiscale and multidimensionality of socio-technical regimes, revealing the variety of regime actors with which GDI promoters interact. Although these initiatives may be rooted in specific cities or regions, their diffusion and growth are influenced by distanced policy interventions, narratives, firms, or institutional arrangements" (Binz et al., 2020, p. 2). Consequently, grassroots niches must simultaneously navigate interactions with both local and supralocal incumbents.

Nonetheless, the reactions and attitudes of these regime actors toward grassroots innovations are not always aligned or consistent, thereby introducing an additional layer of complexity to our understanding of niche-regime interactions. This complexity challenges the conceptualization of mainstream regimes as homogeneous entities and exposes the complicated multiscale relationships that link incumbent actors positioned at different geographic levels (Raven et al., 2012; Dutt,

2022). In line with Hodson and Marvin (2010, p. 482), we argue that regimes should be interpreted not as "monolithic but [as] constituted by multiple relationalities." Thus, we encourage further exploration of the interplay between incumbent actors, a topic overlooked in transition studies (Geels, 2014).

We argue that the different responses of incumbents at different geographic levels reflect the uneven distribution of information among regime actors (Ng et al., 2022). Therefore, understanding how information flows develop within mainstream regimes is critical to explaining the diversity of niche-regime interactions across different locations and geographic contexts. Regrettably, knowledge exchanges among incumbent actors have been largely overlooked in research on socio-technical transition, which has focused predominantly on the dissemination of information within the micro-level and between the niche and the regime (Geels, 2006; Ehnert et al., 2022).

Unlike niche-to-regime information flows, which tend to move from the local to the global (Geels and Deuten, 2006; Costa et al., 2022), our analysis suggests that knowledge exchanges within mainstream regimes are not unidirectional. The experiences of local governments, businesses, and cooperatives, acting as early adopters of grassroots innovation, play a pivotal role in validating niche ideas and enhancing their acceptance among supralocal actors (Laudien and Fernández, 2023). Similarly, supralocal regulators and (inter)national associations of cooperatives can contribute to raising awareness on the potential of GDIs by identifying and disseminating the best practices of innovation niches (Dana et al., 2021).

By extending the taxonomy developed by Wolf et al. (2021), which distinguishes between niche-level intermediaries and niche-regime interfaces, we postulate the existence of *regime-to-regime intermediaries*. These intermediaries facilitate the construction of shared narratives about innovation niches within socio-technical regimes at different spatial scales. Following Hermwille (2016), we hypothesize that these shared narratives can become instrumental in helping to introduce innovation niches in socio-technical regimes by mediating the different perspectives of incumbent actors and promoting coherent responses at the meso level. However, further research is needed to clearly define the roles and functions that these intermediaries should play and to capture how information circulates within socio-technical systems and consolidates to create shared visions of socio-technical transitions (Hodson and Marvin, 2010).

When examining the information flows among incumbent actors, it is important to consider the power dynamics within mainstream regimes, an aspect which is often neglected in the transition literature (Geels, 2014; Smith et al., 2005). Following the definition by Avelino and Rotmans (2009), power refers to the ability to mobilize resources, including knowledge. Analyzing power dynamics can help clarify how knowledge about grassroots innovations disseminates across multiple spatial levels within socio-technical regimes and how these information flows affect the pace and scale of socio-technical transitions (Raj et al., 2022).

Our findings suggest that the acceptance of grassroots innovations within a regime is more likely when these innovation niches are endorsed by actors who have the power to impose structural change (Dutt, 2022). Conversely, socio-technical transitions may be confined to specific geographic areas if local actors who support grassroots innovations cannot mobilize resources on a broader scale (North and Longhurst, 2013). For example, our research shows that some urban environments successfully support the adoption of GDIs at the local level but lack the power to integrate these innovations at a translocal level (Hodson and Marvin, 2010).

Power configurations within the regime primarily reflect pre-existing governance structures, with local incumbent actors being subject to the authority of supralocal policymakers and regulators (Binz et al., 2020; Wolfram, 2018). However, changes in the landscape can also contribute to shaping power imbalances within the meso-level. In line with Geels (2014), our data confirm that the diffusion of neoliberal discourse has

reinforced the power of large corporations at the expense of public organizations and civil society.

The instability of power relations within mainstream regimes further explains the nonlinearity of niche-regime interactions. Shifts in power balances within and across the different geographic levels of socio-technical systems lead to a new distribution of resources within the regime (Hodson and Marvin, 2010), affecting the willingness and ability of incumbent actors to support grassroots innovation. Changes in power configurations are also likely to affect the flow of information within mainstream regimes, leading to the emergence of alternative and potentially conflicting narratives about grassroots innovations (Hermwille, 2016).

Dissecting the intricacies of power dynamics in mainstream regimes is beyond the scope of this study. However, our findings help extend current theorizations by reaffirming the multiscale nature of socio-technical systems (Binz et al., 2020) and suggesting a possible interpretation of the relationship between power configurations, information flows, and niche-regime interactions. Future research should examine the complexity and instability of power dynamics at different spatial scales in the context of socio-technical transitions.

5.2. Practical implications

This study provides insights for policymakers and practitioners working at the intersection of digital transitions and grassroots innovation. By expanding the mapping and description of potential reactions from incumbents across different geographic levels, we aim to assist GDI promoters in refining their strategic approaches and increasing their ability to cope with external threats (Schreuder and Hurlings, 2022; Seyfang and Smith, 2007).

By highlighting a range of niche-regime interactions, this study may also prove useful to local and supralocal actors engaged in GDIs and other grassroots innovations. Not only does our study provide a more comprehensive overview of the types of support that incumbents can provide to grassroots innovations, but it also sheds light on how actions taken at different geographic levels can reinforce or undermine each other. These dynamics depend on the power relationships among regime actors at different spatial scales.

In particular, we urge local and national policymakers to coordinate their interventions in support of grassroots innovations and to facilitate collaboration among grassroots initiatives. These efforts are critical to ensuring the long-term sustainability of GDIs, given the economies of scale inherent in digital platforms and applications (Zhu and Marjanovic, 2021). Urban areas can play a leading role in this endeavor by leveraging their established networks, their global reputation as testbeds of innovation, and their expertise in the governance of digital transitions (Ehnert et al., 2022; Mann et al., 2020; Mora et al., 2023). Nevertheless, for urban areas to catalyze transformative change, local leaders should refrain from exploiting GDIs as competitive tools and should distance themselves from the urban entrepreneurialism logic that dominates public discourses on grassroots innovation in smart city development (Sandoval, 2020).

5.3. Limitations

Despite its contribution to theory and practice, this study has limitations that should be considered in future research. First, our analysis focused on a wide range of European GDIs. Although our sampling approach helped to provide valuable insights, there is room for expansion to include more cases and other geographic contexts and sectors. By including a larger and more diverse sample, researchers can build on our initial findings and extend their implications beyond the current scope (Leung, 2015; Rose and Johnson, 2020).

Expanding the size and scope of our sample also offers the potential for more systematic assessments of niche-regime interactions. Our study maps and qualifies some potential responses of incumbent actors to the

emergence of grassroots niches. However, we did not quantify the intensity or impact of these responses. Replicating our analysis in additional empirical settings may help identify the contextual factors that influence information flows and power dynamics that affect niche-regime and regime-regime interactions. For example, we believe it is important to study these dynamics in alternative institutional contexts characterized by varying degrees of local autonomy (e.g., unitary and federal systems) and different distributions of power (e.g., democracies and authoritarian regimes).

Moreover, future empirical studies should adopt a longitudinal perspective. This approach will enable the systematic tracking of factors that influence niche-regime and regime-regime interactions over time (Pekkarinen and Melkas, 2019).

5.4. Recommendations for future research

In addition to the limitations noted in Section 5.3, future studies should build on this exploratory study to further expand its theoretical contributions. Further research is needed to fully decipher how macro-level trends interact with meso-level factors to determine regime actors' responses to innovation niches (Nwanekezie et al., 2021). Scholars should explore how landscape pressures and information flows lead incumbent actors to change their core beliefs (Markard et al., 2016). Likewise, the relationship between power configurations and information flows across the different geographic scales that form socio-technical regimes also deserves further theoretical and empirical investigation (Avelino, 2021).

Moreover, we invite scholars to examine how knowledge is exchanged within multiscale socio-technical regimes. Our study suggests the existence of regime-to-regime intermediaries playing a central role in forming shared narratives at the meso-level (Hermwille, 2016). However, further research is needed to fully understand how power dynamics alter the direction and intensity of information flows across different geographic levels, thereby influencing the impact of intermediation activities and the interactions of innovation niches with both local and supralocal actors.

6. Conclusions

Our study explores the relationships between the regime and niche actors in the context of grassroots digital innovations and identifies five types of interactions (Inertia, Indirect Support, Antagonism, Direct Support, and Active Collaboration) that describe the potential responses of incumbents to the development of socio-technical niches. By extracting these interactions, we have also shown that the integration of niches into regimes is not a linear or predefined process. Rather, our study highlights the unpredictable and sometimes contradictory nature of the relationships between grassroots innovations and incumbent actors, reflecting the complexity and inhomogeneity of socio-technical regimes.

While the transition literature tends to treat regimes as monolithic and aspatial systems (Hodson and Marvin, 2010; Binz et al., 2020), this work provides further evidence of the multidimensionality and multiscale nature of mainstream socio-technical systems, which include actors situated at different geographic levels and operating at different spatial scales. Recognizing the complexity of socio-technical systems helps explain the dynamics and nonlinearity of niche-regime interactions, but also pushes researchers to further investigate information flows and power dynamics between local and supralocal incumbent actors. Dissecting the intricacies of regime-regime interactions is fundamental to understanding how incumbent actors at different spatial scales can influence the integration of GDIs into mainstream systems and determine the pace and scale of socio-technical transitions.

CRedit authorship contribution statement

Paolo Gerli: Conceptualization, Methodology, Investigation, Formal analysis, Validation, Writing – original draft, Writing – review & editing. **Luca Mora:** Conceptualization, Validation, Visualization, Writing – review & editing, Supervision. **Jun Zhang:** Conceptualization, Methodology, Investigation, Formal analysis, Validation. **Alessandro Sancino:** Supervision, Writing – review & editing.

Data availability

The data that has been used is confidential.

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Appendix A

Appendix 1

Details on the interview process.

Code	Country	Area of expertise	Duration (hh:mm)
I.01	Italy	Tourism	00:56
I.02	Italy	Mobility	00:49
I.03	United Kingdom	Tourism	00:51
I.04	United Kingdom	Multisector	01:09
I.05	Italy	Multisector	01:30
I.06	Croatia	Tourism	00:58
I.07	United Kingdom	CivTech	00:48
I.08	Germany	Information technology	00:45
I.09	Spain	Mobility	00:57
I.10	Italy	Creative industries	01:19
I.11	Poland	Multisector	00:58
I.12	Netherlands	Information technology	00:51
I.13	Spain	Food industry	01:01
I.14	Italy	Mobility	00:49
I.15	France	Food industry	00:36
I.16	Belgium	Creative industries	01:15
I.17	United Kingdom	Food industry	00:44
I.18	United Kingdom	Multisector	00:56
I.19	Germany	Information technology	00:50
I.20	Germany	Food industry	00:54
I.21	Spain	Healthcare	00:44
I.22	Germany	Creative industries	00:37
I.23	United Kingdom	Information technology	00:46
I.24	United Kingdom	CivTech	00:48
I.25	Italy	Tourism	01:17
I.26	Spain	Multisector	00:39
I.27	Germany	CivTech	00:48
I.28	Switzerland	Food industry	00:55
I.29	United Kingdom	Information technology	01:02
I.30	Spain	Multisector	00:38
I.31	Belgium	CivTech	00:46
I.32	Netherlands	Information technology	01:06
I.33	North Macedonia	CivTech	00:46
I.34	Spain	Education	00:41
I.35	Belgium	Food industry	00:52
I.36	Ireland	Food industry	00:40

Appendix 2

Sample of coded passages.

First-order concept	Representative quotes
Lack of awareness on GDIs among supralocal policymakers	“it’s been very difficult to explain the differences between our model and the others, and it is still difficult (...) because there are few platforms that won this challenge” (I.02). “We may not have got our foot in the door with certain organizations because they just didn’t see the benefit of what we were doing on the face of it” (I.07).
Lack of awareness on GDIs among local actors	“...because in the last 50 years, everybody is entrenched in the neoliberal ideology and everybody is thinking in terms of start-ups (...) And it’s not very easy to make them understand that that you have to work together to reach better aims and to reach better goals, and that we need more cooperative” (I.19). “Digital natives are very good with new technologies, but they are not equally prepared and aware of what it means to manage a cooperative” (I.25).
Resistance to digital innovation among local actors	“...the capacities of the local administration are very low and there is an obstacle within the local administration to use digital tools” (I.33). “I wonder to what extent people are aware of technology as a potentially empowering tool” (I.03).
Resistance to digital innovation in the third sector	“Sometimes the perspective of digitalization is not taken into account enough in the sector and when they incorporate digitalization, sometimes they don’t have a positive perspective about it” (I.13). “...that’s even a longer shot for cooperatives to realize the value of the data they have already” (I.21).

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Appendix 2 (continued)

First-order concept	Representative quotes
Public subsidies for SMEs and start-ups	<p>“We got some public funds, but as other cooperatives could have, I mean, it's not like something directly for our project, but (...) it was more like the funds that they have for start-ups and innovation and so on.” (I.09).</p> <p>“We got something through the fiscal deductions for digital innovations in businesses” (I.10).</p> <p>“it's a city owned agency that it's there to collaborate with local businesses and run this type of educative trainings, workshops” (I.08).</p>
Training and incubation programs	<p>“This municipal company works on tourism and sustainability and (...) has now launched an incubator and offers small grants for new innovative start-ups” (I.01).</p> <p>“Unlike other cities, Bologna has the cultural basis to give voice to these instances and to force the municipal government to tackle these issues” (I.01).</p>
Local tradition of grassroots organizations	<p>“a lot of things happen also in certain places and because there is like a tradition or even a narrative that people believe, and they want to continue, and I think that these narratives mobilize people” (I.26).</p> <p>“...the people that stay wherever election goes are more and more sensitive to what we do” (I.15).</p>
Interest of local governments toward grassroots innovations	<p>“You need someone that's passionate and really believes it within the council” (I.18).</p> <p>“The city is interested in supporting the digitalization of local shops. For example, what they already do are simple workshops for shop owners to explain them what they could do going online or having an online channel” (I.08).</p>
Awareness of local actors on the opportunities of digital technologies	<p>“Digitalization is becoming more mainstream, especially when the local administration is faced with allegation of corruption, low level and transparency and so on” (I.33).</p> <p>“From the political site? There's definitely a widely shared view that cities should become more sustainable. So almost all political parties have something in their programs about promoting cargo bikes” (I.08).</p>
Awareness of local actors on the socio-technical issues addressed by GDIs	<p>“It's very common, since a few years ago, that the public administrations have their own climate protection managers, just planning and analyzing and implementing different activities to protect the climate” (I.27).</p> <p>“Governments have been pretty supportive of that, or at least Scottish Government and enterprise agencies, they definitely have an interest when it comes to sort of technology cooperatives” (I.03)</p>
Awareness of supralocal regulators on the value of GDIs	<p>“There is a better understanding of the challenges and also there is some mention of it in the policy documents” (I.31).</p> <p>“We had a technical problem induced by Google, and (...) we had to mandatory upgrade our service to the latest software” (I.12).</p>
Incumbent firms exerting their market power	<p>“We had some quarrels with German Telecom because they use routers for their customers that did not communicate with our service from the very beginning” (I.19).</p> <p>“We couldn't get funding in that way because there's a lot of restrictions” (I.20).</p>
Hostility of financial investors	<p>“It's been very difficult to find investors (...) because we're a cooperative and like all cooperatives we're undercapitalized, because, as you know, all earnings go back to the members, there is no speculation” (I.10).</p> <p>“In Venice, they have been completely unresponsive, the local administration does not listen to new ideas, unless they come from the same political area” (I.01).</p>
Hostility of local politicians toward GDIs	<p>“It's difficult to be judged in a legal frame when you have a political battle and it's difficult for the gatekeepers of this legal frame to open up and understand a complex hybrid model” (I.16)</p> <p>“You have to make a European tender to buy some hosting. It's a problem, it would be better for cooperatives if public institutions could join into a cooperative which provides them with hosting facilities” (I.19).</p>
Supralocal regulations hostile to GDIs	<p>“We need to relax some of the restrictions, for example, in the European single market and the regulation of competition and competitiveness” (I.05).</p> <p>“We are in touch with the local governments. We are preparing a marketing campaign (...) That's one way how we cooperate and collaborate with local governments” (I.08).</p>
Local authorities giving visibility to GDIs	<p>“We are working with around 10 municipalities and the idea was not to have some aggressive promotion, but basically use the positive example of the pilot municipality, which brought two more municipalities... In a way, the work with those municipalities motivated the others to join (I.33).</p> <p>“We're more in contact with the farmers associations and not the farmers directly. I think we have more associations or cooperatives who already have contacted farmers and then they want to use our platform” (I.28).</p>
Local businesses giving visibility to GDIs	<p>“We developed in France with French entrepreneurs, social entrepreneurs in the creative sector” (I.16).</p> <p>“One of the commitments of the cooperative movements is to increase the awareness through conferences, documents, articles” (I.05).</p>
Third sector organizations giving visibility to GDIs	<p>“The regional movement hosted the Conference yesterday and they network between a lot of initiatives in Germany, they put down more than 120 digital start-ups from the food sector” (I.20).</p> <p>“We rely very heavily on being subsidized at the moment, mainly by, you know, Islington Council and local political bodies” (I.17)</p>
Funding from local administrations	<p>“We have also had small funds from Barcelona but the majority of them are from la Generalitat” (I.09).</p> <p>“We also put in an application for a prototype fund from the German government, which looks pretty promising because it's not so bureaucratic” (I.20)</p>
Funding from supralocal administrations	<p>“In most cases they are international donors. We are working closely with the US Aid program. We also have used some funds through EU funded programs” (I.33)</p>
Funding from third sector organizations	<p>“We actually got funding from a foundation” (I.28)</p>

(continued on next page)

Appendix 2 (continued)

First-order concept	Representative quotes
Local administrations using the services of GDIs	<p>“...what this provides is an investment in the form of equity but in a very unique way that is typical of the cooperative movement, which is through shares which are full community shares” (I.18)</p> <p>“One of the cars was put in service by a local public administration” (I.09).</p>
Local businesses using the services of GDIs	<p>“...different persons within the municipalities are using the app to communicate with the citizens” (I.33)</p> <p>“Taxi drivers decided to support us (...) and there are companies that decided to adopt our platform to manage the mobility of their employees” (I.02).</p>
Supralocal businesses using the services of GDIs	<p>“We collaborate with small scales organization like small producers selling directly at the farm, groups of citizens that comes together to organize sales, small shops, something run by 3–4 people, (...) so not the supermarket really, a much smaller size” (I.15).</p> <p>“We have a partnership with the national railway company, we are integrated in their ticketing app (...) and we have a partnership with move IT, one the most popular apps for local public transport” (I.02).</p>
Third Sector organizations using the services of GDIs	<p>“we're working with an organization that represents big banks for instance” (I.24)</p> <p>“NGOs are quite open to collaborate, because they understand the model, they see it's not about enabling one company to own the markets” (I.08).</p>
Regulatory support	<p>“We got support from the cooperative movement, two of the biggest cooperatives are doing projects together with us” (I.21).</p> <p>“Very often we join roundtable where we must confront and discuss with other platforms, for example there is a working group in Milan to which all taxi operators participate” (I.02)</p>
Promotion and coordination of GDIs at the translocal level	<p>“We were called by the European Commission to join the discussion on the European Pillar of Social Rights and on the ongoing directive of platform workers, which we have been audited about” (I.16)</p> <p>“From the central government, we have had this project to start Red Mobilitat” (I.09).</p>
Research institutions as co-founders of GDIs	<p>“An agency, that its government owned and sponsored, is coordinating these efforts with a couple of other partners in Berlin” (I.08).</p> <p>“These are the main organizations that are currently active operational members: I represent a research institute” (I.12).</p>
Third sector organizations as co-founders of GDIs	<p>“The project was born as the operational arm of a research project of Turin Polytechnic” (I.02).</p> <p>“Three of our funders were part of this movement for food sovereignty” (I.28).</p>
Partnerships in research programs	<p>“The cooperative was born in 1990, way before the advent of platforms” (I.10).</p> <p>“Some research labs from universities are working together with us” (I.15).</p>
Co-design of innovation with local administrations	<p>“We were accepted in two European research programs” (I.25).</p> <p>“The municipal government of Barcelona came to us because they were interested in our project and then made the tender to design the code of our software” (I.34).</p> <p>“A lot of those organizations are quite keen to work with us to kind of help develop our product and then in turn we can kind of help them” (I.07).</p>
Co-design of innovation with local businesses	<p>“We kind of approached different platforms that already exist or different organizations that work in the same area and we asked them what is it that you're missing or what's working for you, what's not working for you and how could we work together” (I.28).</p>

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