The Community Networks and Digital Ecosystems Relationship

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Abstract. This paper presents the possible relationships between Digital Ecosystem and Community Networks. Community Networks emerged from the '80s and '90s computer based community services and today are acquiring more understandings related to the public and the business worlds. Digital Ecosystems is a new concept emerging before any empirical declination. Therefore it is not clear nor simple to understand how the two entities could help each other. We suggest to analyse and compare them by using the Socio-Technical Infrastructures theory. In order to reach this goal a theoretical framework to support the description of these phenomena is presented by relying upon a set of shared dimensions. This intends to make translatable two realities that have important points of contact and potential synergies, as well as non-secondary differences. What we found is that Community Networks could provide community participation methodologies and ubiquitous broadband infrastructures to enable Digital Ecosystems' advanced services, while those services could increase the potential of CNs. The paper ends with some suggestions for future Digital Ecosystems research: improve the empirical and the policy research, and consider DEs application other than business ones.

Keywords: Community Networks, Digital Ecosystems, Socio-Technical Perspective, Infrastructures.

1 Introduction

Digital Ecosystems (DEs) are a new innovation framework promoted by the European Commission to help revitalizing SMEs clusters with Peer-to-Peer and Open Source Software based services. They are being studied by an interdisciplinary group of researchers within the EC Information Society Technologies FP7. DEs are being theorized and experimented by footing on the idea that the digital divide is likely to be reduced. But SMEs in Europe are facing two difficulties at the same moment: the lack of broadband network accessibility and of advanced and enabling services.

Community Network (CN) is an empirically based concept that extends its meaning from the bottom-up on-line services for local communities purposes to the top-down publicly managed local information infrastructure. Digital Ecosystem assumes an efficient network infrastructure as a prerequisite for the construction of a DE. Is it possible to consider the CN primarily as a tool for the creation and the access to the network infrastructure? Is it possible to imagine a common approach to local innovation that makes synergistic a territorial intervention aimed at developing simultaneously a network infrastructure and local digital ecosystems? What are the lessons learned for the future digital ecosystems research?

2 Socio-Technical Theory

The socio-technical perspective represents the last paradigmatic change in the social studies of science an technologies. It challenged the functionalistic perspective and started considering the micro and macro social production of artefacts and the reproduction of society as a whole complex process (Latour and Woolgar, 1979; Knorr Cetina, 1981; Bijker, Hughes and Pinch, 1987; Bijker and Law, 1992).

Socio-technical construction processes are not linear and highly context-sensitive. Between the many approaches - like SCOT and ANT - we chose the Socio-Technical Infrastructures (STIs) theory because: (a) it precisely goes beyond the mechanical interpretation of infrastructures and sustains relational understandings; (b) it represents an application of Actor-Network Theory to infrastructures understanding; (c) it is intrinsically relational; and (d) by connecting social practice with technology it accepts the different understandings on infrastructures and helps underlining specific social process and technologies.

2.1 Socio-Technical Infrastructures

Infrastructures are usually understood as technological substrates, celebrating the technology-centric

vision. Differently Star and colleagues suggested to consider infrastructures as artefacts emerging from practice, directly connected to human activities and material structures (Star and Ruhleder, 1996).

> In my own research this became clear when I did fieldwork over three years with a community of biologists (...) few biologists ended up using the system. It seemed the difficulty was not in the interface or the representation of the work process embedded in the system, but rather in the infrastructure – incompatible platforms, recalcitrant local computing centers, and bottlenecked resources. We were forced to develop a more relational definition of infrastructure, and at the same time, challenge received views of good use of ethnography in systems development. (Star 1999:380)

Star and Griesemer (1994) suggest considering technologies as infrastructures, as transparent sets to be analysed also from an ethnographic perspective. Infrastructures are *transparent* because they invisibly support some tasks and are far more complex than any other technological artefact. They are usually taken for granted since they play a background role, and different actors perceive them differently. For example, we all use sinks everyday but tend to ignore the draining infrastructure underneath, whereas a plumber would have a clear view of the infrastructure but not of the reasons why we use water.

In order to get over taken-for-granted technical details, Star suggests maintaining an ethnographic perspective when gathering and analysing data. Some tricks, proposed by Star herself, might do to better to analyse infrastructures in empirical analysis: 1) Identify different narratives used by actors to make sense of the infrastructure; 2) Help resurface the invisible work by somehow going backstage, where things are hidden; 3) Emphasise paradoxes in the infrastructure (Star, 1999, 2002).

Through a socio-technical lens, then, the infrastructure is not an implemented technological system [any more]. Under a relational lens it is more related to a *when* than to a *what*. Therefore infrastructures occur when local practices are made possible by larger-scale technologies and usually emerge with the following dimensions (Star and Ruhleder, 1996; Star, 1999): embeddedness, transparency, reach or scope, learned as part of membership, links with conventions of practice, embodiment of standards, built on an installed base, becomes visible upon breakdown, fixed in modular increments.

2.2 The C.I.S.G. Framework

We developed the C.I.S.G. framework (Botto and Passani, 2007; Botto, 2008) as a conceptual tool based on the socio-technical theory of infrastructures. The objective is to create a common relational platform that may prove useful to understand any kind of broadband-based innovations that could be understood as socio-technical infrastructures (STIs). It has been created by: (a) identifying the main elements that constitute ICT-based innovation, thus (b) underline the need to re-defining them through a relational dimension within specific contexts.

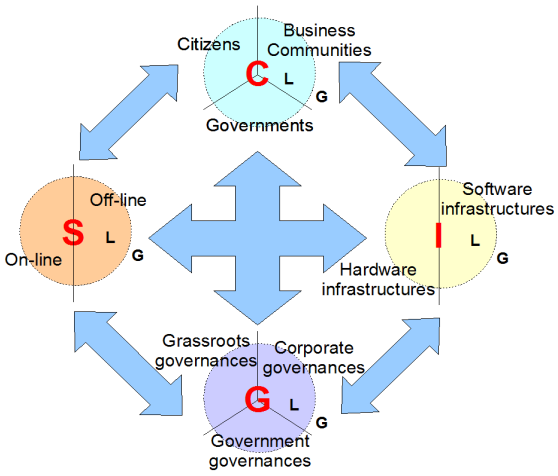

Figure 1: The C.I.S.G. framework for STIs

We identified four dimensions (Figure 1) that could help us relationally defining any STI:

- *Communities*. The stakeholders that participate in a STI are various in role and interest. The many dimensions (ISG) and innovation phases identify specific actors and interests.

- *Infrastructures*. Hardware and software infrastructures are the technical part of STIs. They are socially constructed and produce standards and constrains while enabling services.
- *Services*. The production of services for communities should be the core aim of any infrastructure.
- *Governances*. Different stakeholders control and/or coordinated different STIs-related activities by using authorities, structures and institutions.

The dimensions are plural because we wish to emphasize their multiple and heterogeneous character. The sub-dimensions have only indicative character. The researcher is asked to use the sub-dimensions that emerge as relevant in his/her specific research.

The C.I.S.G. framework has been designed to study STIs under a relational perspective, thus reminding the researcher that the definition of each element must be settled with reference to its relation with all other elements. The analysis of such relations may provide an added value to the study only if contextualised, by explaining actual complex relations and continuity among elements of specific cases. There are tree levels of adoption of the framework: (1) relational description of conceptual STIs – chapter 3 and 4 –; (2) relational comparison of different STIs – chapter 5 –; and (3) in depth analysis of specific cases. The third level should involve an ethnographic-like research and the research tricks proposed in section 2.1 (see Star, 1999, 2002).

3 Community Networks as STIs

3.1 What is a Community Network?

Different areas of interests provide specific definitions for Community Networks (CNs). Historically it is connected to some local web-based services:

> Community networking has its origins in services such as the Free-Net, which emerged in the '80s and early '90s to offer online access, sometimes along with local news and information.(Shapiro, 1999)

The Community-Mediated Communication (CMC) research community define CNs as "off-line communities that also meet on-line":

> Community computing is computer networking among and between residents, organizations, government and businesses in a geographically bounded setting for local purposes and activities. (Kavanaugh et al, 2005)

The more activists' understanding of CNs is the one that produced the "new community networks" definition that is published by the Computer Professionals for Social Responsibility (CPSR) group:

> New computer-based community networks are a recent innovation that are intended to help revitalize, strengthen, and help expand existing people-based community networks much in the same way that previous civic innovation have helped communities historical. (Schuler, 1996)

New computer-based CNs are used to strengthen the existing people-based CNs and according to Schuler (2001) the core elements are: (a) *civic culture*, direct participation in collective decision via new media; (b) *computer professionals in the community*, who are responsible for democratic medias while working with community teams; and (c) *democratic technology*, created by means of an interdisciplinary and collaborative work. The cheap and easy-to-deploy wireless devices are recently enabling citizens to construct and manage their own access infrastructures (Botto & Passani, 2007). Latterly, Deliberative Community Networks are intended to join top-down and bottom-up forces to sustain citizens' direct participation in the choices of the local government (De Cindio et al, 2007).

The more recent engineering-business understanding tends to consider CNs as a synonym of "networked infrastructure" for local community needs:

> Public participation in building broadband infrastructure and fostering the development of broadband services is often advisable for several reasons. (...) For local governments it is often a straightforward step to become – directly or indirectly – a telecom infrastructure operator, since their high-speed networks interconnecting public institutions are already in place and are being updated. (Chlamtac et al, 2005)

The new infrastructures can reduce the digital divide in districts under Local Government control and foster local development for citizens and business sectors alike. Moreover, this provides the public-

sector actor with the new role of “telecom operator” and regulator of services in its own network.

3.2 Community Networks as STIs

The four definitions we gave to CNs could be analysed by using the C.I.S.G. framework (Table 1). Moreover, from the literature and web research we can identify four CNs typologies which are described by using the C.I.S.G. framework in Table 2.

Table 1. C.I.S.G. analysis of the four CNs definitions.

	Historical	**Activists'**	**Engineering**	**CMC**
C	Business-grassroots initiatives	Grassroots initiatives Public participation	Local Government and business initiatives	Citizens, business and government initiatives
I		Democratic technology	Public local broadband infrastructure	
S	Online access, news and information	Democratic technology	On-line access and advanced services	On-line services
G		Bottom-up based and institutional regulation	Government regulation	

Table 2. C.I.S.G. analysis of four CNs typologies.

	Traditional	**New grassroots**	**Government**	**New government**
C	Grassroots	Grassroots	Government	Government
I	-	Bottom-up infrastructures	Top-down infrastructures	Top-down infrastructures
S	Bottom-up services	-	-	Top-down high level services
G	Influence policies	-	-	-

Traditional CNs are those described by Schuler (1996) and Shapiro (1999): basically as an outcome of FreeNets in the '80s and of the efforts of computer specialists who create and maintain technologies in collaboration with citizens. The aim is to provide communication and information services to citizens, but also to facilitate the direct participation of citizens in decisions concerning community. The Seattle Community Network is the most traditional and widely known CN, and its slogan is “Democratic Technology for All”.

The new grassroots CNs represent the evolution from the hardware point of view of traditional CNs, sharing the ideology related to the deep democratic potential of new technologies. This typology of CN is generally initiated at grassroots level and its main aim is to facilitate the creation and management of network infrastructures by citizens. In rural communities the aim is to reduce the digital divide, thus to bring broadband infrastructures - optical fiber, XDSL, wireless mesh networks, etc. - to areas outside the control of operators. In cities the aim is generally that of setting up more antennas, namely public hot-spots for wireless services.

Government CNs refer to the engineering definition (Chlamtac et al., 2005). These are quite recent cases where local authorities, often supported by institutions and funds from Ministries and International associations, participate in the creation and management of regional or local (city) broadband networked infrastructures. Telecoms companies and Internet Services Providers are often involved by governments to create and manage infrastructures and services.

New government CNs are the government CN adopting services of virtual presence such as Virtual Helsinki and Digital City Kyoto (see: Ishida 2000). At the end of the '90s the activist and engineering visions of CNs converged on the term “Digital Cities”. Some FreeNets and CivicNets became fruitful spaces of information and dialogue among citizens. On-line communication spaces for citizens began to adopt the spatial metaphor of the city. Currently, under the term “Digital Cities”, one can find studies on architectures, infrastructures, services, policies and communities. Nevertheless, the bottom-up approach of CNs in the '90s has been absorbed by institutional research and business initiatives (Ishida & Isbister, 2000; Tanabe, Van den Besselaar & Ishida, 2002; Van den Besselaar & Koizumi, 2005).

4 Digital Ecosystems as STIs

4.1 What is a Digital Ecosystem?

Dini (2007) suggested the latest multidisciplinary definition of Digital Ecosystems considering the social, the computer and the natural sciences understanding and underlining the following categories: agencies, languages, identity and trust, services, network infrastructure and P2P environment (Table 3).

Table 3. multidisciplinary Digital Ecosystem definition (Dini, 2007)

Social Science	Computer Science	Natural Science
A community of users A shared set of languages A set of regulatory norms and guidelines to foster trust A population of services An open-source service-oriented infrastructure	Several categories of users A set of languages A security and identity interface A service oriented-infrastructure A service development environment A distributed P2P run-time environment A distributed persistent storage layer	A population of interacting agents/applications A distributed evolutionary environment A dynamic, adaptive, learning, and scale-free network infrastructure

Another way to define a DE is to describe it in relation to a Business Ecosystem, which is a group of companies that co-evolve capabilities around a new innovation by working cooperatively and competitively (Moore, 1993). It result that a DE is the technical infrastructure that enables advanced services and open distribution of "digital objects":

> ... the technical infrastructure, based on a P2P distributed software technology that transports, finds, and connects services and information over Internet links enabling networked transactions, and the distribution of all the digital 'objects' present within the infrastructure. Such 'organisms of the digital world' encompass any useful digital representations expressed by languages (formal or natural) that can be interpreted and processed (by computer software and/or humans), e.g. software applications, services, knowledge, taxonomies, folksonomies, ontologies, descriptions of skills, reputation and trust relationships, training modules, contractual frameworks, laws. (Nachira, Dini and Nicolai, 2007:5)

The DE can be also considered as a process of territorial innovation concretised by its multi-stockholders oriented approach (see Rathbone and Di Corinto, 2005; and Passani, 2007). From this perspective the DE concept also takes into account the fact that European SMEs are strongly connected and dependent on their local realities and therefore the global solutions (also in terms of ICT) must be adaptable to the territorial and sector requirements of these enterprises. Therefore, the DE is a "service oriented infrastructure" populated by various services, that becomes an instrument for local innovation that passes from the creation and activation of diverse communities of users and develops one "shared set of languages" and a "set of regulatory norms and guidelines to foster trust".

4.2 Digital Ecosystems as STIs

Starting from the definitions of DE given in the previous section and positioning ourselves within a sociological prospective we will try to define which communities, which models of governance, which infrastructures and services can characterise digital ecosystems. DEs are, today, first of all a wide research field, still under development. This implies that they are not yet a concrete and stabilised reality. Therefore we will refer here at the experience made on the one hand in two territories – Aragon Region, Spain; and Midlands, England (Passani, 2006) - in the framework of the DBE project and, on the other hand, with a future scenario for DE implementation.

The *communities* underlined by the DE experiences are: Regional Catalysts, that coordinate the regional training and community building activities; Influencers, that want to influence the adoption behaviour and conditions of SMEs; Adopters, divided in more/less active "software developers" (drivers/implementers) and "users" (discoverers /users). These actors can be related to two of the three components of communities defined in the CISG model: Business Agencies (Adopters) and government agencies (Influencers and Regional Catalysts). The citizens' component, which characterises grass-roots CNs, is currently absent.

Considering *infrastructures*, the DE can be seen as a distributed and decentralized software

oriented architecture which is composed of three macro-layers (Kennedy, 2007). Within the OPAALS project the DE technical architecture is actually being improved. Since a well stabilized high-level architecture is still missing we will refer to the DBE project technical components, which will exist in some form in the future DEs. The Service Factory (SF) serves to design and develop services and services adapters. The Execution Environment (ExE) functionality is to host services at the local level. The Evolutionary Environment (EvE) serves to optimize the whole system by monitoring the consumption, facilitate service consumption in the nodes where they are more likely to be consumed, and support the automatic composition of services.

The *services* allowed by DEs are those that will be created within SMEs participation processes. Actually we can say that the core DE service is the one that constitute the DE infrastructural dimension, that is the service-oriented infrastructure. The automatic composition of services is not possible at the moment.

The DEs *governance* is one of the most complex issues at hands. Actually a governance model has not been well defined and the different communities – scientific, business and government – are practicing their own governances (see M.Darkling, 2008).

The DE future scenario (Table 4) is based on the hypothesis of a full implementation of the service-oriented infrastructure with its adaptive characteristics and evolutionary instruments and a full, independent use by end-users. The scenario is positioned, therefore, in a temporal range of three to five years. This time frame is based on responses collected during a delphi analysis conducted at the end of the DBE project where most of the 120 interviewed players were optimistic for a full realisation of digital ecosystems in a period of three to five years specifically (see Passani, 2006).

Table 4. The present and Future DE scenario

	Existing DE	**DE scenario**
C	composed of business agencies and government agencies+researcher. Top-down oriented	composed of Business agencies and government agencies+researcher+Open Source community Top-down oriented but possibly also grass-roots
I	service oriented infrastructure	service-oriented infrastructure
S	top-down evolved services	bottom-up services + top-down services + evolved automatised development of services
G	community governance	balance between community and government governance

In the future it is expected that: (a) there will be a participation of the local Open Source and grassroots communities; (b) the service-oriented infrastructure will be improved; (c) the processes of bottom-up and automatized development of services will start; (d) there will be a balance between community – SMEs and grassroots – and government governances.

5 Constructive coupling between CNs and DEs

Footing on the C.I.S.G. analysis it is therefore possible to consider the relationship between CNs and DEs (Botto and Passani, 2007).

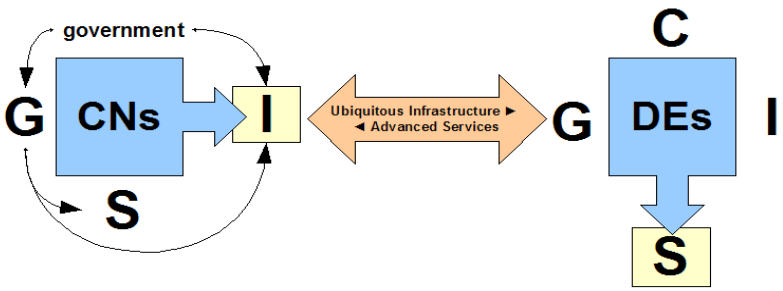

Figure 2: Interplay between Government CNs and DEs.

The first point is that "infrastructural CNs" – also "new grassroots", but especially "government" and "new government" CNs – could bridge the infrastructural digital divide and enable advanced DEs services (Figure 2). Another axes of relationship between DEs and CNs is the participatory character of grassroots CNs, both on-line service-oriented and infrastructural (Figure 3). The bottom-up DEs push could be empowered by the participatory methodology that is typical of local communities autonomous action, especially when enriched by computer scientists involved for the creation of democratic and open technology (see Schuler, 1996).

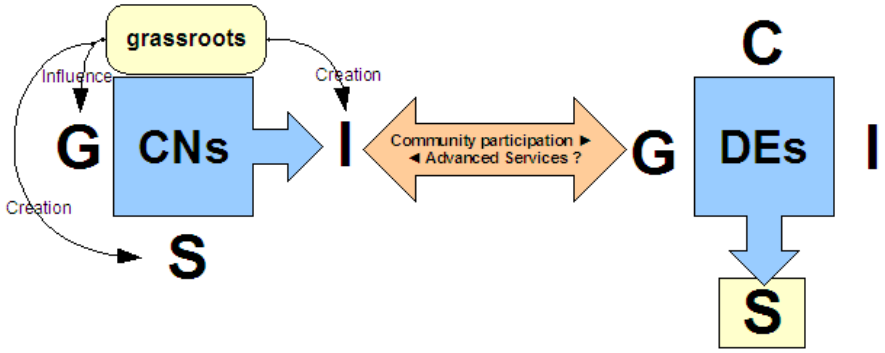

Figure 3: Interplay between Grassroots CNs and DEs

Combining the two axes, for the relation between CN and DE we can suggest three interplay vectors or kinds of coupling that might generate a virtuous circle at broadband-based local development level (Figure 4).

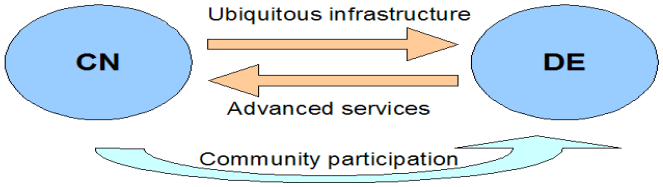

Figure 4: The possible positive interplay between CNs and DEs.

It can be said that once a mature 'Government CN' and an efficient DE emerge with a full technological development, it will be populated by a cloud of services and players. Once this happens, three possible synergies between CN and DE will emerge:

- *CN and DE as a synergic regional development strategy* that implements both a government CN and a DE, providing communities affected by the digital divide with ICT access and advanced services simultaneously.
- *DE and CN as sources of different but possible complementary services*. As it was developed, DE can be interpreted as an instrument for providing users with advanced services; by providing the possibility to make already existing B2B services interoperable, and by providing SMEs with an effective path for ICT uptake and collaboration boosting. Besides this, DE can be interpreted as an important knowledge provider. The research community currently studying the DE could become, in the near future, a 'knowledge provider', (using the same technological infrastructure) making available advanced knowledge, supporting SMEs, and developing a territorial necessity towards innovation. CN, as 'government CN', could provide, through the DE, those services now available through the web, related to fostering citizens and SMEs participation to the Information society (i.e.: eGovernment, eProcurement, eHealth and eInclusion services). Merging CN and DE services would also lead to the enlargement of the number and the typologies of communities, and thus augmenting the possibility of populating the ecosystems. This would then reduce one of the gaps that now

separate the DE and the CN.

- CN as a source of well-tested experience related to community participatory practices. Starting from the history of the development of Italian civic networks, an action-research could start by taking into account the possible dialectics between grass-roots CNs' pattern of participation (commonly replicated in communities of practice) and government governance. This can guide the DE research community in developing further a participatory process for defining models of governance applicable to the DE at the local and global levels.

6 Conclusions: lesson learned for DEs research

It is important to remind and clarify here some points. First, this paper represent a first step toward a theoretically informed relationship between DEs and CNs. We developed the C.I.S.G. framework out of the socio-technical infrastructures (STIs) theory in order to get a possibility to compare different locally and broadband related innovations. Those innovations are suggested to be understood as STIs, therefore their dimensions should be understood relationally. Second, the empirical research that will follow this theoretical step should (1) better explain "how" DEs and CNs are interconnected in practice, and (2) involve dimensions and research tricks suggested by Susan Leigh Star and colleagues (Star and Ruhleder, 1996; Star, 1999) and briefly suggested in sections 2.1 and 2.2.

The Table 5 shows the possible synergies between CN and DE following the C.I.S.G. definition from the final user point of view: the hypothetical case of a rural house in the tourist sector explained by Botto and Passani (1997:45). The outline could be modified if the observation point is changed to a software house (drivers/implementers) involved mainly in the planning phase and in the development of the DE. Consequently, a participative process emerges, always guided and pulled ahead by the local public actor through a top-down approach.

Table 5. Future possible interplay between CNs and DEs

	Government CN	**DE**
C	Citizens, Public Administration, Research Centers, Universities, Science Parks, Enterprises	SMEs tourist sector, other enterprises of the tourist value chain, software house and other service providers
I	Top-down **Infrastructures** Ubiquitous infrastructure	Top-down **Infrastructures** Service oriented infrastructures adjusted to local needs
S	Top-down services Online access, user support, information	**Top-down high level services** Connectivity, advanced market place functionalities, interoperability related services **Bottom-up services** Several advanced services for users: from security management to CSM, from communication services to marketing services
G	**Government regulation**	To be developed

Concluding, we would like to present some open issues that might prove to be fundamental for the future DEs research. The first issue concerns the *need to undergo a phase of detailed empirical research on DEs*. Despite some initial cases, DEs have not been analysed thoroughly yet, in order to define more specifically both actors and activities, not to mention background processes. The C.I.S.G. framework has been helpful for analyse DEs and CNs through literature and some case studies. Even then, the socio-technical approach used suggests to analyse more in depth phenomena through the STIs dimensions, emphasizing structures and paradoxes that define and support the specific located practices.

What is still missing in the research on DEs is a continuation of the empirical analysis, that is the shift from the analysis of specific practices through which it is possible to improve the model. To ethnographic technique one can add other tools – even quantitative tools like the social network analysis (SNA) – provided the research tends to emphasize and not hide the characteristics and problems in specific DEs.

The second issue is related to the *need to analyse DEs by taking into consideration other aspects of the broadband-based local innovation* as CNs. In this paper we have emphasized the level of the

broadband-based local innovation, in which context both CNs and DEs play different but potentially synergistic roles. This leads us to two elements. The first is that, both empirically and theoretically, it is possible to analyse DEs effectively even on a different level of analysis. The second suggests that some elements deriving from other local innovation cases might eventually relate to DEs, thus modifying the model in some cases. For example, this could bring about DEs typologies that were not meant for business but are characterised by particular dimensions and processes.

The third issue concerns the *need for a more in-depth study of policies for DEs at a regional level*. Since DEs represent real aspects that must be adopted and facilitated at regional level, the time has come to take advantage of the interplay between empirical research and theoretical modelling to study which actors and processes in regional policies can help the growth and sustainability of DEs.

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