Collaboration Networks for Innovation and Socio-economic Development: European and Latin American Perspectives on Digital Ecosystems Research, Local Readiness, Deployment Strategies and Their Policy Implications

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Abstract. International cooperation and knowledge transfer among countries has become increasingly important in the last decades, giving opportunity to a set of multiple interaction programs particularly amongst developed and developing regions. This paper discusses the feasibility of the adoption of Digital Ecosystems (DEs) in the Latin American context, based on the experience of deployment of DEs in the European Union. Different deployment experiences in the European context revealed the need of a methodology for planning and implementing DEs that resulted in a set of tools for measuring the maturity grade of localities related to the deployment of DEs and the need of an impact index for understanding its long-term implications of the dynamics of their implementation. This paper proposes a new methodological framework that integrates concepts related to ICT adoption, connectivity and absorption capacities and recognises the strong influence of social capital over these. The paper concludes with the description of a methodological tool oriented towards the mapping, evaluation and modification of scenarios related to ICT adoption process among multiple agents.

Keywords: Collaboration networks; Digital Ecosystems; Latin America; quantitative- qualitative methodological framework; ICT adoption; absorption capabilities; connectivity; social capital; sustainable socio-economic development; policymaking.

1 Introduction: Collaboration Networks and Digital Ecosystems

Digital Ecosystems (DEs) are context-specific socio-technical systems enabling sustainable socio-economic development at the local/regional scale or within a particular industrial sector, driven by networks of social actors and economic agents, and

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entirely reliant on distributed architectures for their technical components. DEs can be seen as socio-technical processes that offer ultimately affordable and trustworthy cooperative solutions through investment and engagement by the local stakeholders. DEs are composed by virtual communities that are connected by an open source and low-cost peer-to-peer infrastructure that minimises transaction costs by allowing more efficient participation of stakeholders in the socio-economic system through the integration and sharing of knowledge in a given territory or sector. As a result, DEs maximise the participation of small enterprises with each other and thus allowing and reinforcing their participation in global value networks. This facilitates their access to regional and global markets through the principle of more participation and collaboration for better competition.

Economists commonly describe Digital Ecosystems as an enabler (tool) of development [1] [2]. From an economics empirical perspective, these collaboration networks are:

- A socio-technical system and process
- A link between the 'micro-economy' and the 'macro-economy'

The latter definition implies that the networks minimise transaction costs within clusters at the regional level through knowledge integration and sharing within the region, and thus through more dynamic Regional Innovation Systems. They maximise the benefits to enterprises in participating to Global Value Chains because, when referring to SMEs and distributed markets, evidence shows that more collaboration could lead to better competition and performance.

The findings and results on deployment plans at the European level confirmed that there are some differences in regional needs, requirements and opportunities for DEs. Typically, the regional variations reflect the differences in innovation capabilities, in enterprises' ICT capabilities, and in the characteristics of the social capital of the region. Nevertheless, regions interested in the deployment of DEs are typically characterised by their commitment to regional development and by their support to regional innovative capabilities.

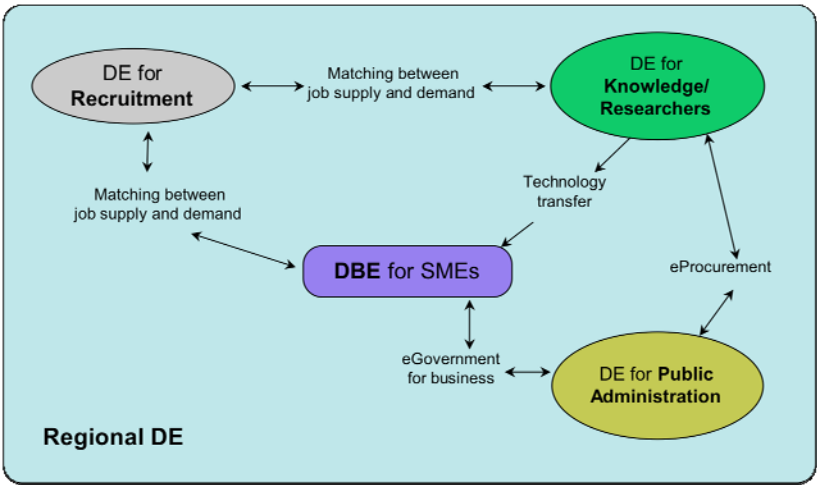
More precisely, regions interested in the implementation and deployment of Digital Ecosystems are characterised by:

- An interest in mechanisms for sharing and for open diffusion of knowledge within local clusters, supported by the interaction and Europe-wide/ international co-operation between regional/local networks;
- A need for easy-to-use services with high user value;
- A shared interest and support for distributed infrastructures and Open Source; and
- An interest for the promotion of the knowledge "embedded" within local territories, and the recognition of the importance of knowledge sharing and best practices through regional innovation programs and plans.

Based on the practical experiences of deployment strategies and plans studied in several EU funded research projects (i.e. DBE project, the DBE Lazio Project and the OPAALS project), an identification of different uses and applications of Digital

Ecosystems emerged for the regional level of intervention. Four different typologies have been identified within a Regional Digital Ecosystem (RE): Digital Business Ecosystems (DBEs), Digital Ecosystem for Public Administration (DE-PA), Digital Ecosystems for Researchers (or DEs of Knowledge – DEK) and Digital Ecosystems for the Labour Market (or DEs of Work - DEW).

Figure 1 is self-explanatory for understanding the possible co-existence of different ecosystems (with different objectives and purposes) within a RDE. The way a RDE would evolve and be composed in terms of the interaction of different 'ecosystems' is context- specific.



Source: Passani, Rivera León, 2009

Fig. 1. A Regional Digital Ecosystem

DEs are adaptable to different regional applications and needs, and they are thus not exclusive to the business sector. Each region has the opportunity to shape DEs to fit regional and local priorities best.

In the context of their deployment and evaluation, the first concern is to identify potential users and their needs for planning the deployment of these collaboration networks and thus for evaluating and assessing their impact.

2 Planning the Deployment of Digital Ecosystems and Its Evaluation: Past and Present

One of the core objectives of DEs research is to provide regional stakeholders with new approaches and strategies for fostering sustainable regional development.

The following sub-sections discuss different strategies for the introduction of DEs at the regional level, with a focus on practical issues, difficulties and key success factors encountered by regions and key-players that have deployed or are planning the

deployment of Digital Ecosystems. The subsection ends with the introduction of the Latin American perspectives on these deployment strategies and the evaluation of the deployment of DEs.

2.1 Existing Tools, Methods and Methodologies for Assessing and Deploying Digital Ecosystems

Feasibility studies are appointed as an essential starting point when planning the deployment of Digital Ecosystems and collaboration networks, in order to relate local needs, plans and strategies to the different technology necessities and requirements.

More complex methodologies include:

The Catalyst-Driver methodology
The methodology is offered as an approach to bring a Digital Ecosystem to local SMEs. The methodology requires the appointment of a Regional Catalyst that is an organisation that has certain strengths and 'social capital' among local stakeholders; and the engagement of 'Driver' SMEs, that are first movers in the construction of the network dynamics. Catalysts and Drivers reinforce each other building the bases for a community of members of the local ecosystem. The Catalyst-Driver methodology relies heavily on the social capital of regional actors that need to be convinced of the benefits of the network in order to protect mutually their social capital 'asset'. This means that the methodology relies on the characteristics of these institutions and their capacity to grow and succeed, but most importantly, this depends on the previous existence of a minimum level of connectivity among institutions, firms and the local government that establish the foundation of social interaction that is required by an efficient collaboration network.

Balanced Scorecard self-assessment system
The Balanced scorecard is a strategic management technique that seeks to make objective and quantitative measures using four headings or 'perspectives' in order to provide a comprehensive and balanced view of an organisation that is able to usefully inform management. In the case of Digital Ecosystems, the four perspectives used are: Financial, User, Business Process, and Development. The aim of the Scorecard is to investigate how the different characteristics of each regional catalyst influence the role and the success of achieving the network objectives. It serves as a complementary tool of readiness and effectiveness of the proposed Regional Catalyst.

Regional Maturity Grade
The Regional Maturity Grade (RMG) serves as a tool for regional analysis. It is a theoretical framework used for interpreting innovative processes at the regional level. It is formed of different techniques of analyses, qualitative and quantitative, that give a complex description of reality, thus becoming a useful instrument for programming and policy interventions.

The RMG function is conformed of three key elements: Social Capital (SC), Innovative Capacity (IC), and the relation between SMEs and ICTs (ICT). The variables analysed under each of the key elements are:

- Social Capital: improvement through networking. The territorial SC has five dimensions and several variables. The first dimension, leadership towards innovation, analyses the entities recognised as innovators in the public and private sectors as a point of reference for obtaining information. The second dimension, Relational Typologies, looks at face-to-face contacts, participation in associations, information sharing, resources sharing, and participation through common plans. Density is the third dimension, analysing the overlaps between various relational typologies, and the rate between potential and real links. The fourth dimension is called Differences, introducing in the network the various typologies of actors (by number and preponderance). Finally, Trust is the fifth dimension, looking at the level of trust per each typology of actors.
- Innovative capacity: change for better competing. Three dimensions are analysed in the IC element: characteristics of the human resources; ability to generate knowledge; and transmission and diffusion of knowledge and access to the market. The first dimension looks at variables such as percentage of the local population with a higher education degree, technical and scientific education, employees in the services sector (high-tech) and employees in the manufacturer sector (medium and high-tech). The second dimension analyses variables like public and private expenditures in R&D; local participation in European projects; international scientific publications; etc. Finally, the variables analysed in the third dimension include percentage of innovative enterprises in the manufacturing and service sectors; total expenditures in innovation in the manufacturing and service sectors; introduction of new products in the market; and the amount and number of investments from early stage venture capitalists.
- Relations between SMEs and ICTs. Two dimensions are analysed. The first one, analyses broadly the characteristics of the business sector. The second one, ICT use by SMEs, analyses variables such as access to networks, and SMEs activities regarding e-business.

The RMG describes the territory from a socio-economic point of view and measures the dynamics and modifications resulting from a development intervention. It is useful for understanding the regional background and it is usually undertaken within feasibility studies to the deployment of the collaboration network.

Social Network Analysis

Social Network Analysis (SNA) is generally used as a preliminary phase when planning the deployment of DEs at the regional level. It helps in characterising and measuring the socio-economic dynamics of a network at the local level in order to evidence relations and the potentials to collaboration, the structure of leadership, the flows of communication and transmission of knowledge, the nature and intensity of the inner links to the territory, and the social capital. The visualisation of the network allows an initial understanding of the processes of collaboration and the temporal changes on them. SNA serves as a tool for understanding collaboration capabilities on an ecosystem-like environment.

2.2 The Construction of an Impact Index for Digital Ecosystems

As the research became more complex there was an increasing interest from policy-makers and researchers on understanding the socio-economic impact of Digital Ecosystems. An impact index of DEs deployments was then defined [4] as an aggregated composite indicator, formed of four evaluation accounts: financial, user, economic development and social. It is an open and scalable tool for assessing the socio-economic impact of DEs at local/regional level; sharing the principles of three different methodologies: impact assessment studies through the 'before-after' approach of project impact assessment (1), methods of valuation of tangible and intangible goods from Value Network Analysis (2), and Multiple Account Cost- Benefit Analysis (3).

In the framework of the construction of the impact index, a multiple-account CBA global methodological approach was used. Multiple-Account CBA evaluation frameworks capture all of the factors considered in a socioeconomic CBA, but present the results in several distinct evaluation accounts. The use of different evaluation accounts allows having a clear description on what the consequences and trade-offs, for instance of the deployment of DEs are.

Four evaluation accounts were designed in order to provide an overall assessment related DEs deployment:

- (Public/Private) Financial Account: net return or cost to 'investors'.
- User/Consumer Account: net benefit to users as 'consumers' of what the collaboration network provides.
- Economic Development Account: micro-economic effects and macro-economic net benefits related to productivity, growth and employment.
- Social Account: Community and social impacts, mainly net benefits on social capital.

Although its complexity and its completeness, the impact index revealed to be ahead as a theoretical framework if compared to real cases of deployment. For instance, the framework did not consider at that point any progress evaluation or ex-ante evaluations or impact assessments. This revealed to be a limitation when trying to implement it.

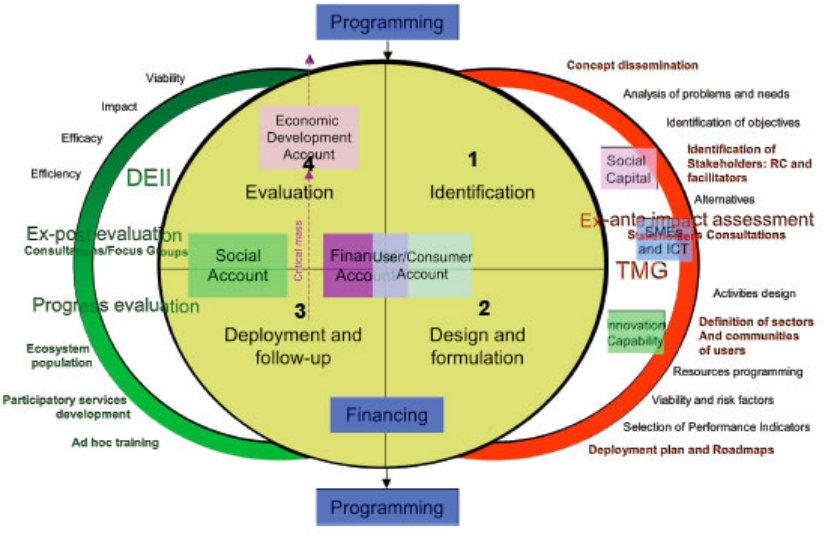
2.3 The Latin American Context and the Adaptation of the Analytical Framework

The research above was further extended to the Latin American context. The activities undertaken were mainly oriented towards partnership building, knowledge transfer and sharing of experiences in the area of DEs research for development. The central focus of the activities is the extension of existing European networks to Latin American and Caribbean (LAC) research communities. The aim is to stimulate the collaboration between communities and networks engaged in research on multi-disciplinary approaches concerned with the role ICTs and new media have on the evolution and dynamics of the Information and Knowledge Society in the European Union and LAC countries.

One pilot case study was planned in Argentina, province of Buenos Aires, and more specifically in the city of Morón; with applicability to the metal-mechanical

industry. When meeting policymakers and researchers of the region, and presenting the 'European' methods for planning the deployment of DEs and assessing/evaluating their implementation, it was revealed that these methods were rather ahead on applicability as no real use cases were already taking place, and thus no real benchmark case (or zero case) existed.

Based on concepts more suitable to international cooperation projects common to th e Latin American context, a new conceptual framework was introduced, taking into account the bases of methodologies for the implementation of projects for development such as the '*Marco Lógico*" approach [5]. This framework also situated all the previous methods and tools developed by previous projects. Figure 2 presents the 'adapted' conceptual framework.



Source: Rivera León, 2009

Fig. 2. Four phases for planning the deployment of Digital Ecosystems

Figure 2 shows four phases related to the deployment of Digital Ecosystems: Identification (1); Design and formulation (2); deployment and follow-up (3); and Evaluation (4). Several deployment steps and requirements complement each phase. The right side of the figure is more related to ex-ante actions previous to the actual deployment of the network. This right side, joined by the red semi-circle, is the 'area' of application of the previously developed Regional/Territorial Maturity Grade methodology. The left side of the figure, joined by the green semi-circle corresponds to the phases of applicability of the DEs Impact Index. Also to note, is that this methodological framework introduces ex-ante impact assessments (i.e. through Stakeholders consultations); progress evaluations; and ex- post evaluations (i.e. through consultations and focus groups). The four accounts of the Impact Index introduced before are situated in the 4 main phases of the deployment process. Their location is related to the moment where data for its completion can be obtained. For instance, data for the

User/Consumer Account and Financial Account can be obtained from the beginning of the process, but only completed until Phase four is finished; the Social Account between phases 3 and 4; whereas the Economic Development Account requires the completion of the deployment process. The arrow pointing upwards in the Economic Development account refers to the time spam between post evaluation of the impact assessment of economic variables (that usually requires a long-period of time to be concretised).

This conceptual framework then raised the question on how could a Latin American region be situated in this framework and theoretically and empirically compared ex-ante to any European deployment case in terms of readiness and possibility of successful deployment, given the considerable structural differences in both regions. This stimulated a debate on the role of collaboration among regional socio-economic stakeholders in Latin America, linkages, and their impact on innovation activities, as well as the role of intermediate institutions in speeding up innovation processes.

The mentioned problems regarding different scales, absence or inadequacy of certain problems enforced the creation of new concepts related to collaboration networks not only in the triad of innovation level, Social Capital, and ICT-SMEs relationship, but also in introducing new concepts such as the connectivity level and absorptive capacities [6] [7] [8].

Two representative cases can be underlined in order to understand the heterogeneity and the difficulty in comparing Latin America and EU deployment cases, particularly considering the constitution of indicators for their comparability. The first one is the use of patent data as a result of innovation efforts. It is broadly known that developing countries have not the same patenting rate than developed countries, especially if one takes in consideration the gap and barriers confronted by SMEs. As a result of using patents to measure innovation efforts and results (IER) in Latin America, an analysis on innovation capabilities tends to show that the patenting level is near to zero in most cases, which means that there is very low level of IER. However, several studies [9] underlined that in spite of the comparative lack of IER in LA, it is possible to measure multiple gradients of efforts and results that not necessarily points to obtaining a new a patent, but impact into the innovation level of the firm (specially in incremental innovations at firm and local market level). The same analysis can be applied to R&D investments: while the raw indicator is near to zero in the private sector in Latin America, it is known that informal R&D teams are more commonly found in developing countries and that their results generally are oriented to incremental solutions to “every day” problems.

Former discussions focused the problem of inter-regional measurement in efforts to develop a set of indicators that could be both broadly comparable but also sensitive enough to collect differences between regions at a qualitative level.

3 New Approach on Measuring Collaboration Networks through Digital Ecosystems

The pre-feasibility analysis of a Digital Ecosystems implementation in a region relies on the idea that the technology involved in a network is not a mechanism that *generates* innovation and connectivity in firms by itself. The main vision, instead, is that

ICTs are a booster of pre-existent relationships and innovative behaviours, allowing the users of these technologies to enrich their productive activities.

This is very important when evaluating the role of ICTs in the implementation of a collaboration network. How does a policy maker know if a region is prepared to transform technology into a boosting mechanism of a local innovation system? What are the priorities for each region to enforce this process?

The methodological framework developed is based on four dimensions that summarise what is considered as the main aspects of ICTs as a networking and innovation booster in a specific context: the absorption capacities level, the connectivity, ICT adoption and the social capital.

3.1 Absorption Capacities

Absorption capabilities are usually defined [6] as the ability of given actors to recognise external information, assimilate it, and apply it within the system these actors are part of. These capacities are not just related to the access to knowledge and information, but also on the ability of identifying useful knowledge and generate new knowledge. Absorption capabilities are not developed automatically. They require time and the development of previous competencies, and are consequently influenced by the framework conditions of the region.

The absorption capacity dimension concentrates indicators of those aspects of the local environment that allow agents to understand and modify their context, such as innovation capabilities and results, human resources qualifications and characteristics, quality management on firms and organizations, among other.

The absorption capacities are key for the firms and organisations in order to understand their environment. This understanding makes them able to achieve their objectives relatively more efficiently. This set of indicators could point out "innovation based agents", able to develop learning process under dynamic and adapting strategies, by analysing their context. On the other hand, very low absorption capabilities will show firms with lack of strategy, with no interest on innovation activities and without qualifications.

3.2 Connectivity

This axe is related to the potential of the relevant stakeholders in the region to establish relationships and linkages with other relevant stakeholders (internal or external to the region). As was the case for the absorption capacities axe, 'connectivity' is not just the simple interaction with other agents, but rather selected exchanges and the capacity to prioritise relationships according to the 'use' that these could give to the (network of) stakeholders.

This axe takes into account not only firm-to-firm linkages, but also institutional and organisational relationships. Also, it is interesting to underline that linkages could be analysed beyond the dual indicator based on the existence of the relationship, for example considering the quality or the impact of that interaction.

Recent literature [10] points that there is a strong relationship between absorption capabilities and connectivity, since the good development of the first dimension in many cases could enrich and empower the frequency and quality on the second one.

3.3 ICT Adoption

ICT adoption takes the form of a requisite for establishing collaboration networks among enterprises through Digital Ecosystems. Although it is a pre-requisite, this approach to development is not a technocentric approach, since the success relies on the capabilities of the region of reference and its actors/agents. Technology thus, through Digital Ecosystems, plays a 'boosting' role of dynamic cooperative processes highly influenced by the interaction of absorption capacities, connectivity and social capital.

This set of indicators is oriented to measure the existence and uses of different technologies related to information and communication, such as basic infrastructures as broadband diffusion and its characteristics, and more complex ones, such as the properties of ICT use in production processes among enterprises.

It is interesting to note that these three dimensions could be analysed separately, but because of the dynamics of their interaction, they should be analysed jointly. This is particularly important when evaluating policies related to the adoption of new technologies.

For instance, first approaches on supporting ICT use in developing countries only considered the ICT adoption dimension, leaving behind both connectivity and absorption capacities. The result is an increase of the *stock* of available technology, but without a business and networking enforcement, because of the lack of previous absorptive capacities (i.e. firms that do not understand the benefits of ICT use) and connectivity (very weak relationships and links between firms and between firms and institutions).

3.4 Social Capital

In the world of economics [7] social factors have been increasingly recognised as central to the competitive challenges of the knowledge-based economy. The density and structure of social networks is crucial for acquiring democratic organisation in a society, and thus also in business interactions. The OECD [8] defines social capital as "*networks together with shared norms, values and understanding that facilitate co-operation within or among groups*". Following Steinmueller lines, 'social capital' considers formal organisations in the society and social networks, including 'communities of practice'. The concept of 'social capital' is thus central for a complete analysis of collaboration networks for innovation.

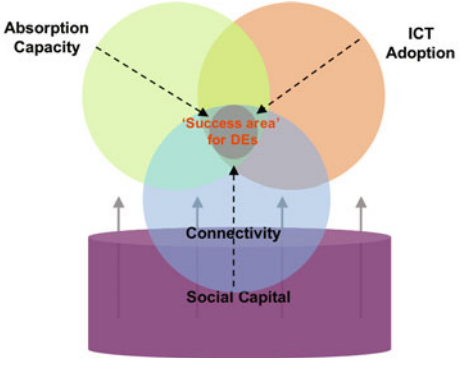
Under this conceptual framework, a region (political geographical concept) is understood as a localised system of interaction in which networks of stakeholders play a central role. This recognition supports the analysis of the role of social capital and knowledge exchange as relevant elements for local innovation. Generation and accumulation of social capital is mostly based on trust and made possible as actors share norms, values and understanding [9].

The effect of stronger social capital tends to generate inertia towards the convergence of a successful implementation of ICTs in boosting regional development. A weak social capital creates obstacles in achieving this objective.

The above discussion can be graphically represented as shown in Figure 3. Each of the axes, or determinants, described above corresponds to one of the spheres in the

figure. The arrows try to express a quantitative maximisation exercise, as it will be discussed in the next section. The graph shows that in the maximisation of the three axes (i.e.. where the three spheres overlap) there is a 'successful' area related to the deployment of DEs for innovation in a given region. As it will be discussed below, this framework allows the graphical identification of studied stakeholders (i.e. enterprises) in the region. The equilibrium, or 'success area', would be when most of the enterprises in the region are located in the intersection of the 3 axes.

Figure 3 would be better represented in a tri-dimensional way (this is why social capital is expressed geometrically as a cylinder). For this effect, social capital would act as an 'elevator' to the maximisation process of the three axes. For example, a strong social capital in the region would 'push up' the three axes, and thus accelerate reaching maximum values in each axe. The contrary would happen with a low level or weak social capital.



Source: Rivera León, Kataishi, 2009

Fig. 3. Determinants of the 'successful' deployment of collaboration networks through Digital Ecosystems

4 How to Map These Complex Socio-economic Interactions?

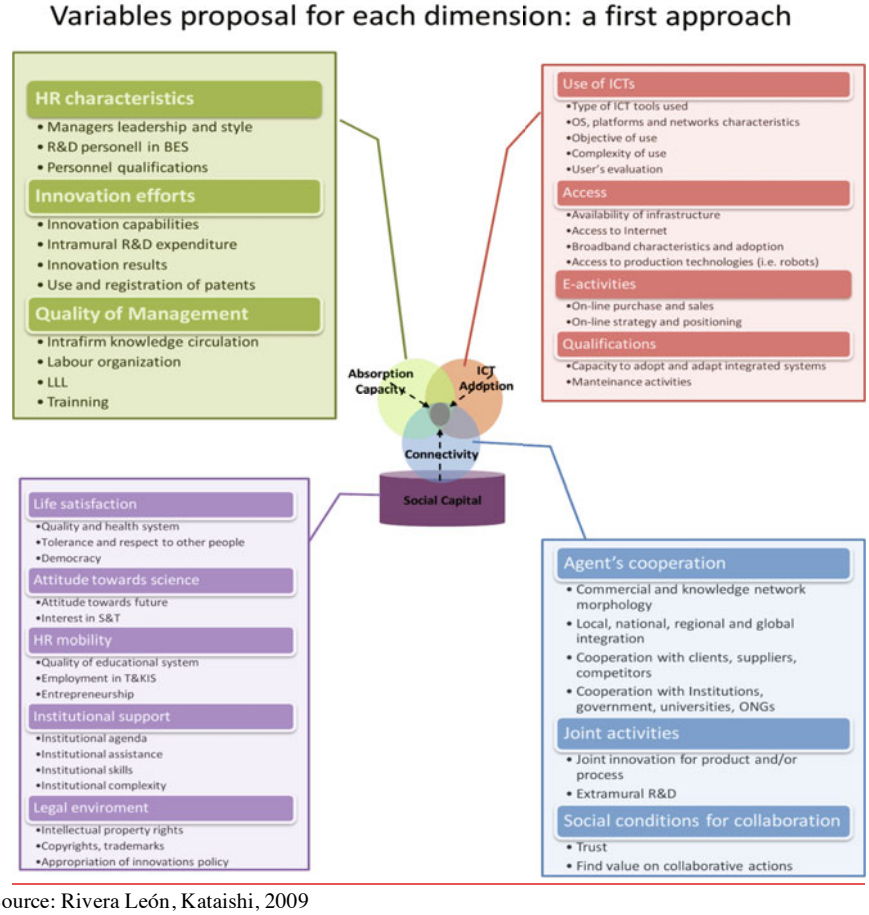
As it was mentioned in the previous section, the presented conceptual framework is able to map local readiness and the structure of socio-economic interactions in a given region towards the deployment of DEs. This is possible thanks to a (mathematic) maximisation process through the use of several indicators serving as proxy variables for the definition of the concepts describted above.

Several secondary and primary sources exist in the EU to approximate quantitatively the axes of the conceptual framework. An exhaustive list of variables, indicators and data sources are presented in the Appendix A of this paper.

In Latin America, however, the statistical systems are generally less developed, generating comparability problems not only between Latin American countries and the EU, but also amongst many LA countries. These problems are particularly important when looking at S&T indicators, use and diffusion of ICTs and the performance of institutions.

Regarding this lack of systemic and periodic official information in many Latin American countries, particularly in a number of aspects that concerns the sets of indicators that were proposed before, the main methodological challenges are: to generate primary data from specially-build case studies and surveys; and to study the availability of secondary sources including those available from other research projects.

Three main surveys were developed in the scope of the Latin American case study undertaken in the city of Morón, province of Buenos Aires, Argentina. One of them was oriented to understanding ICT use in the manufacturing industry in Morón. The second focused on understanding the general characteristics of the metal mechanical industry; and the third one was based on an in-depth interviews methodology in order to map the behavior, the relationships and the influence over other manufacturing



Source: Rivera León, Kataishi, 2009

Fig. 4. A proposal of the set of indicators and variables used to map complex socio-economic interactions through Digital Ecosystems

industries of organisations and institutions (NGOs, chambers of commerce, public bodies). Additionally, these interviews also captured the interests and business strategies of enterprises in the industry (i.e. through interviews with the CEOs of the main companies). Regarding secondary data for understanding the structure of the region, the study focused on analysing the results of 15 in-depth interviews of existent research projects, mainly focused on NGOs.

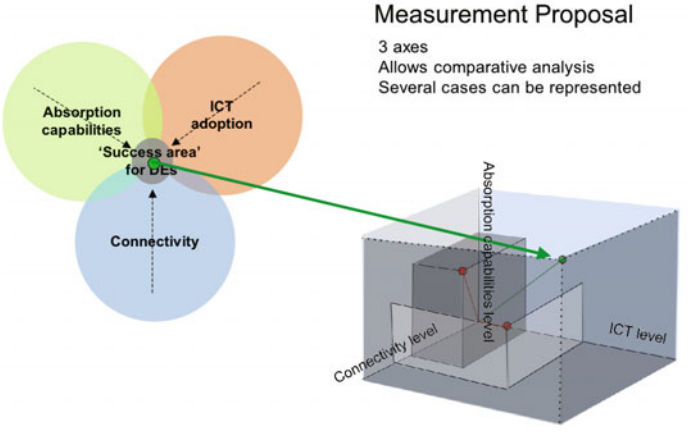
Figure 4 presents the complete list of indicators used to map each dimension of the study. This is a schematic view focused on showing how this methodology works in practice. The set of indicators can be amended depending on the case of study and data availability.

There is also a sort of hierarchy among indicators. Primary indicators are represented in the figure with bold names and are set as the 'head' of sub-sets of indicators. Those sub-sets of variables are usually ones that cannot be replaced because of their importance to the dimension considered.

As a result of the normalisation and addition of the different sub-sets of indicators, subtotals for each sub-dimension can be built. This process allows to make a normalized 0-1 value for each dimension considered, that consequently allows the representation of these several aspects in a three axes graph (figure 5).

Mapping quantitatively the axes above is very much related to mathematical integration. For example, taking an integral can also be described as a process of dimensional reduction, i.e. going from many variables to few variables, and thus losing some information of the studied phenomenon. This is particularly common in all statistical exercises and in economic models trying to model reality.

The analytical framework is a very expressive qualitative tool (the 3 domains/axes: ICT adoption, connectivity, absorption capacity, influenced by social capital); and quantitative (the triangular coordinates of the maximum of the same three axes) representation of data that characterises well the properties and characteristics of the business collaborative networks in the studied region.



Source: Rivera León, Kataishi,2009

Fig. 5. Mapping the characteristics of enterprises in a given region

The benefits are on the relatively simple way to achieve a graphical quick view of the relative positioning of each region studied. Also, this scheme allows researchers and/or policymakers to see where the strengths and weaknesses of the region are. Figure 5 presents an example of the mapping exercise and characterisation of the enterprises in a studied region.

In this figure, the green point located at the maximum values of the three axes is also found in the 3D cube on the right of the picture, explaining the tri-dimensional aspects of the methodological framework. This green spot is in fact representing 'one given' enterprise. Examples of other enterprises are the red spots on the cube. While one has similar values in terms of the indicators in the axes of ICT adoption and connectivity, while having lower levels of absorption capabilities; the other has high levels of connectivity and absorption capabilities while having lower ICT adoption.

The average of all the dots, which can be taken exactly or which can be easily estimated by the human eye aided by the three circles, gives a single number and graphical representation that not only sums up the contributions of all the enterprises in a clear way, but, by so doing, gives a very significant global indicator for the region that is comparable no matter the differences of the framework conditions (i.e. between the developed and the developing world) as the framework in itself represents them internally already. In other words, it presents macroscopic information from the aggregation of microscopic information.

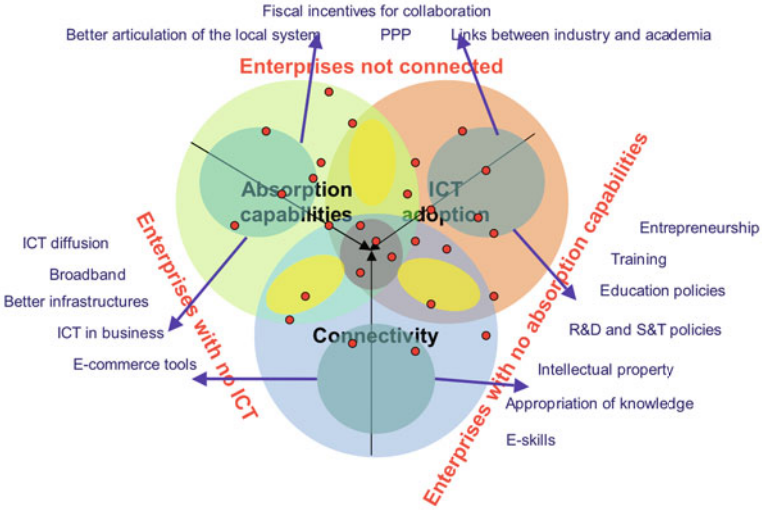
5 Policy Mixes for Enterprises and Regions

In the previous sections an approach and measurement proposal for following an ICT implementation process through DEs was introduced. This however should be complemented with a set of policy actions related to the identified stages on the deployment process. The objective of this section is to describe the linkages between the presented tools and specific policy actions that are able to modify certain scenarios.

Being able to map enterprises in the way described above also has strong implications in terms of policymaking and the implementation of different policy mixes in the studied regions towards the goal of building collaboration networks for innovation and sustainable socio-economic development through Digital Ecosystems.

Figure 6 represents graphically the three dimensions that have been described before together with the representation of hypothetical enterprises and their situation in the framework. This is shown together with sets of different policy mixes applicable to each possible scenario in a given studied region during its implementation process. The shaded yellow areas represent three different types of situations in which enterprises can be located. In the top part of the figure, there is the conceptual case where enterprises are not connected (1), but show both ICT adoption and absorption capabilities in higher to medium levels. Secondly, the right area of the picture shows enterprises with no absorption capabilities (2), but that are highly connected among them and with their institutional system, together with an important presence and use of ICTs. Finally, in the left area of the figure there are the enterprises with no ICTs (3) but with good levels of absorption capabilities and connectivity.

The shaded blue areas represent areas where the located enterprises just have good levels of one of the 3 axes. For enterprises located in these shaded areas a combination of policies is required as marked with the blue arrows in the figure.



Source: Rivera León, Kataishi, 2009

Fig. 6. Policy mixes for enterprises and regions

It is important to underline the main steps that lead to the policymaking focus of this section. In Figure 5, the measurement proposal showed the importance of mapping the interactions in 3D (3 axes) in addition to a 2D representation (circles within axes). Following this methodology, the feasibility studies would try to map the condition in which the agent's actions take place for each location of a given enterprise, in order to identify behavioral-based clusters. It is expected that relatively homogenous characteristics among firms will be shown, together with some outlier cases that will have to be analysed in isolation. This will end in a similar representation to the one shown in Figure 6, showing firms positioned following the results of a mix of indicators described and explained extensively in Figure 4; but also positioned within three dimensions, enabling the diagnosis of the situation of a given region as a whole.

As it is well-know, the elaboration of policy mixes is not an easy task, especially in developing countries [10], since it implies several sets of restrictions that affect not only the elaboration of policies per-se but also this affects the effectiveness of interventions given the institutional and resources related limitations.

Despite this, this proposal is focused on the development of policies oriented towards specific issues that would be detected through the methodological process in itself, and *ceteris paribus* through the limitations and restrictions identified through previous research and in-depth analyses of the region.

Policymaking can be defined using multiple criteria. Two of them are of the interest of this paper. On one hand, the mechanisms that may lead policymaking processes could be based on the average position of firms shown in the 3D representation. On the other hand, policies could be oriented to the benefit of a given critical group, characterized by the lack of a number of attributes (i.e. a group of enterprises with no connectivity).

The area where the majority of firms would be positioned would determine the policy focus. As it is shown in Figure 6, the lack of some elements implies the relatively precise set of tools that would influence and modify the particular disposition of firms within the approach.

For example, if the results of a given study would show that most of the 'agents' are positioned in the top part of the figure, actions should then be oriented to simulate connectivity among firms and between firms and institutions. Having this acknowledgement, there would be several sets of policy practices available for governments to implement, such as fiscal incentives for collaboration, promotion of linkages among components of the local innovation system, PPP oriented policies, etc. The same logic can be applied to other possible situations derived from the Figure: concentration for firms on the right side implies that policies should be oriented to enforce firm's capabilities. If they were situated on the left side, the need for implementing efforts towards ICT adoption and use would be revealed. The possible policymaking actions are determined by the under- development and under-representation of the considered dimensions. It is also possible to find situations where interventions on more than one spheres are needed.

One last thing to consider is the relative importance of each considered dimension and their practical implications (absorption capabilities, connectivity and ICT adoption). Traditional interventions in developing countries are normally focused on the left side of Figure 6, relegating both, connectivity issues but specially absorption capabilities in enterprises.

In comparison, ICT related deficiencies are usually associated with resources driven polices, as the main goal is to 'connect' these technologies to users or firms, and the first step usually consists in the acquisition of the technology in itself, which can be done form example through financial assistance and support. Connectivity and absorption capabilities are more complex issues that would probably require much more than only financial resources, but rather medium and long-term strategic approaches to policymaking.

From this perspective, the key element that emerges from this complex system [6] appears to be the absorption capabilities of agents. Nevertheless, the modification of each parameter is very much related to generic development policy that involves education, Science and Technology and socio-economic transformation issues, among others.

The proposed methodological framework has the faculty of giving a macro-picture based on microeconomic data, and most importantly it makes able to drive qualitative conclusions based on quantitative data. It is also an ideal tool for measuring regional performance in the developing world, with the view of comparing this performance with developed countries without the logical bias related to the different stages of development. The implications in terms of policymaking are large and are to be exploited when introducing innovation policies.

6 Conclusions

This paper analyses the implementation process of Digital Ecosystems in multiple regions. The first section was oriented to summarize the state of the art of DEs definitions and goals.

Secondly, this work underlined the relevance of DEs as an approach that considers technology adoption as a social process, driven by social networking actions and collaboration. This implies at least three important elements. First, there has to be a form of collaboration among social actors (in other words, connectivity among agents is required for the implementation of DEs. Second, it is required that social actors have something to offer to other actors, otherwise the collaboration may not be possible and/or sustainable (it can be said that learning capabilities and knowledge storage of agents –absorption capabilities- have to be heterogeneous and close to the state of the art, and possibly determined by the local common practices). Third, it is supposed that ICTs can perform a "booster" role of both connectivity and absorption capabilities.

Having this into account, the paper described four spheres that represent the D.E. implementation scenarios: the social capital, the ICTs adoption level, the agent connectivity and absorptive capacities level. One of the main contributions of this work is the development of a measurement methodology capable of quantify the variables present in the four considered dimensions. In this sense, groups of indicators that are available in through European statistics and in some Latin American countries have been identified.

The second main contribution of the paper is the proposal of a representation of firms in a 3D graph that considers the dimensions previously underlined, in order to identify the deficiencies in a region and make an accurate diagnostic regarding the challenges that the implementation of DEs implies in a specific context. Finally, the proposed methodology allows to orient policymakers towards a set of actions to be taken into account during the implementation process.

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Appendix A – Set of Variables, Indicators and Data Sources for Measuring Collaboration Networks for Innovation through Digital Ecosystems in the EU

Category in new methodological framework	Indicator	Data source	Level of availability	Available years
Connectivity	Product innovation jointly with other enterprises or institutions	Question 2.2 (INPOTW) 'Who developed these product innovations'. Answer: 'Your enterprise together with other enterprises and institutions'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2002 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Process innovation jointly with other enterprises or institutions	Question 3.2 (INPCSW) 'Who developed these product innovations'. Answer: 'Your enterprise together with other enterprises and institutions'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2003 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Extramural R&D	Question 5.1 (RRDEX) 'Did your enterprise engage in the following innovation activities: Extramural R&D''. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2003 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Acquisition of external knowledge	Question 5.1 (ROEK) 'Did your enterprise engage in the following innovation activities: Acquisition of other external knowledge'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2003 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Public financial support for innovation activities: local or regional authorities	Question 5.3 (FUNLOC) 'Did your enterprise receive any public financial support for innovation activities from: local or regiona authorities'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2003 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Public financial support for innovation activities: central government	Question 5.3 (FUNGMT) 'Did your enterprise receive any public financial support for innovation activities from: central government including central government agencies or ministries'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2004 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Public financial support for innovation activities: the European Union	Question 5.3 (FUNEU) 'Did your enterprise receive any public financial support for innovation activities from: the European Union'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Information and co-operation for innovation activities: suppliers	Question 6.1 (SSUP) 'How important to your enterprise's innovation activities were the following information sources: suppliers of equipment, materials, components, or software'. Answer: 'High'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Information and co-operation for innovation activities: clients	Question 6.1 (SCLI) 'How important to your enterprise's innovation activities were the following information sources: clients or customers'. Answer: 'High'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Information and co-operation for innovation activities: competitors	Question 6.1 (SCOM) 'How important to your enterprise's innovation activities were the following information sources: competitors or other enterprises in your sector'. Answer: 'High'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Information and co-operation for innovation activities: private researchers	Question 6.1 (SINS) 'How important to your enterprise's innovation activities were the following information sources: consultants, commercial labs, or private R&D institutes'. Answer: 'High'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Information and co-operation for innovation activities: universities	Question 6.1 (SUNI) 'How important to your enterprise's innovation activities were the following information sources: Universities or other higher education institutions'. Answer: 'High'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Information and co-operation for innovation activities: government	Question 6.1 (SGMT) 'How important to your enterprise's innovation activities were the following information sources: government or public research institutes'. Answer: 'High'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Co-operation for innovation activities	Question 6.2 (CO) 'Did your enterprise co-operate on any of your innovation activities with other enterprises or institutions'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Enterpises using the Internet for interacting with public authorities	Percentage of enterprises using Internet for interaction with public authorities - for obtaining information	Countries	2003 - 2008
	E-government usage by enterprises	Percentage of enterprises which use the Internet for interaction with public authorities	Countries	2003 - 2008
Absorptive capabilities	Students on tertiary education levels as a percentage of total students. Levels 5-6 (ISCED 1997)	Eurostat Regional statistics/Regional Education Statistics	NUTS 2	1998 - 2006
	Employment in technology and knowledge-intensive sectors	Annual data on employment in technology and knowledge-intensive sectors at the regional level. Percentage of HTEC on Total (all NACE branches). Eurostat regional statistics/High-technology manufacturing and knowledge-intensive services sectors	NUTS 2	1996 - 2007
	Job-to-job mobility of employed HRST	Annual data on job-to-job mobility of HRST, employed, between 25 and 64 years, percentage	Countries	1996 - 2007 (no data for the EU25)
	R&D personnel in Business enterprise sector (BES)	Total R&D personnel (researchers/RSE and technicians-equivalent staff/TEC) as a percentage of active population. Eurostat regional statistics/Research and Development	NUTS 2	1997 - 2007
	Patent applications	Number of patent applications to the EPO per million of inhabitants. Eurostat regional statistics/Patent applications to the EPO (European Patent Office) by priority year.	NUTS 2	1994 - 2005
	Registration of industrial designs	Question 9.1 (PRODSG) 'Did your enterprise registered an industrial design'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Trademarks	Question 9.1 (PROTM) 'Did your enterprise registered a trademark'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Copyright	Question 9.1 (PROCP) 'Did your enterprise claimed a copyright'. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2005 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Life long learning	Participation of adults aged 25-64 in education and training. Thousands. Eurostat regional statistics/Regional socio-demographic labour force statistics - LFS adjusted series.	NUTS 2	1999 - 2008
	Intramural R&D expenditure (GERD)	Total intramural R&D expenditure (GERD) in the business enterprise sector (BES) as a percentage of total GERD. Euros per habitant. Eurostat regional statistics/Research and Development.	Countries	1997 - 2008
	Intramural (in-house R&D)	Question 5.1 (RRDIN) 'Did your enterprise engage in the following innovation activities: Intramural (in-hourse) R&D''. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2002 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Business investment	Business investment - Gross fixed capital formation by the private sector as a percentage of GDP	Countries	1997 - 2008
	Training	Question 5.1 (RTR) 'Did your enterprise engage in the following innovation activities: Training''. Answer: 'Yes'. CIS IV, survey data	Only Spain and Italy/enterprise sizes and NACE sectors	2002 - 2004 data, gathered in 2005, forming the CIS IV 2004
	Risk aversion/entreprenuership	Eurobarometer flash survey No. 160. Question 12 'One should not start a business if there is a risk it might fail' Answer: Agree. Page 102 report.	Countries	2004 (date of fieldwork)

	Access to Internet	Enterprises having access to the Internet, % of total	Countries/different size of enterprises	2003 - 2008
	Enterprises having purchased via computer mediated networks. Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2008
	Enterprises having received orders via computer mediated networks. Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2008
	Enterprises with broadband access. Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2003 - 2008
	Enterprises having purchased on-line over the last calendar year (at least 1%). Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2003 - 2008
	Enterprises having received order on-line over the last calendar year (at least 1%). Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2003 - 2008
	Enterprises which have received orders via Internet over the last calendar year (excluding manually typed e-mails). Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2003 - 2007
ICT adoption	Enterprises which have ordered via Internet over the last calendar year (excluding manually typed e-mails). Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2004 - 2007
	Enterprises using LAN and Internet or extranet in reference year. Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2003 - 2008
	Enterprises using open source operating systems. Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2007 - 2008
	Enterprises selling on the internet and offering the capability of secure transactions. Percentage of total enterprises.	Eurostat/Policy indicators	Countries/different size of enterprises	2007 - 2008
	Enterprises's turnover from e-commerce	Share of enteprises' turnover on e-commerce. Enterprises' receipts from sales through electronic networks as a percentage from total turnover. I2010 benchmarking indicators	Countries/different size of enterprises	2003 - 2008
	Automated data exchange with customers or suppliers	Percentage of enterprises using automated data exchange with customers or suppliers	Countries	2008
	E-invoices	Enterprises sending and/or receiving e-invoices. Percentage of total enterprise with at least 10 persons employed. Survey data	Countries	2007 - 2008
	Use of software solutions for analysing clients	Enterprises using software solutions, like CRM (Customer Relation Management) to analyse information about clients for marketing purposes. Percentage of enterprises with at least 10 persons employed. Survey	Countries	2007 - 2008
	Availability of IT systems for employees working from home	Enterprises having remote employed persons who connect to the enterprise's IT systems from home, %	Countries/different size of enterprises	2006
	Interest in science and technology	Eurobarometer special survey No. 224. Question A1.5 'Interest in new inventions and technologies' Answer: Very interested. Page 169 report.	Countries	2005 (date of fieldwork)
	Attitude towards risk from new technologies	Eurobarometer special survey No. 224. Question A15b.6 'If a new technology poses a risk that is not fully understood, the development of this technology should be stopped even if it offers clear benefits' Answer: Disagree. Page 269 report.	Countries	2005 (date of fieldwork)
	Attitude towards science	Eurobarometer special survey No. 224. Question A12a.1 'Science and tecnology makes our lives healthier, easier and more comfortable' Answer: Agree. Page 226 report.	Countries	2005 (date of fieldwork)
	Attitude towards future	Eurobarometer special survey No. 225. Question B7.2 'The next generation will enjoy a better quality of life than we do now' Answer: Agree. Page 153 report.	Countries	2005 (date of fieldwork)
Social capital	Trust	Eurobarometer special survey No. 225. Question B8 'In general, would you say that you trust other people' Answer: Trust. Page 156 report.	Countries	2005 (date of fieldwork)
	Democracy	Eurobarometer special survey No. 223. Question D1.13 'Please tell me if you are satisfied with the way democracy works in your country' Answer: Satisfied. Page 7 report.	Countries	2004 (date of fieldwork)
	Quality of the educational system	Eurobarometer special survey No. 223. Question D2.4 'Please tell me if you are satisfied with the quality of the educational system' Answer: Satisfied. Page 16 report.	Countries	2004 (date of fieldwork)
	Quality of the health system	Eurobarometer special survey No. 223. Question D2.6 'Please tell me if you are satisfied with the quality of the health system' Answer: Satisfied. Page 19 report.	Countries	2004 (date of fieldwork)
	Tolerance and respect for other people	Eurobarometer special survey No. 225. Question B5.6 'Please indicate how important you consider it to be tolerance and respect for other people' Answer: Important. Page 148 report.	Countries	2005 (date of fieldwork)
	Life satisfaction	Eurobarometer special survey No. 225. Question B6 'How satisfied are you with the life you lead' Answer: Absolutely satisfied. Page 151 report.	Countries	2005 (date of fieldwork)