
# OPAALS PROJECT

Contract n° IST-034824

# WP11: Bridging Digital Ecosystems Research to Regional Development and Innovation in the Knowledge Economy

## Del11.8 – Preliminary study on methodologies for DE socioeconomic impact analysis


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**Short Description**:

The deliverable represent the output of task 11.5 and provide a preliminary definition of a Digital Ecosystem Impact Index (DEII). DEII has been developed with the aim of providing regional stakeholders and policymakers with a flexible, open and scalable methodology supporting DE territorial adoption. In this deliverable DEII accounts and variables are delineated and the work to be done in phase three is also described.

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**Partners contributed**: T6 ECO

**Made available to**: Partner and the EC

| **Versioning** | | |
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| **Version** | **Date** | **Name, organization** |
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**Quality check**

**Internal Reviewers**: Francesco Botto (Create-NET); Runa Sarkar (IITK)

**Dependences:**

| | |
|---|---|
| **Achievements*** | DONE:<br>- Further theoretical development of Digital Ecosystem Impact Index (DEII) methodology<br>- Definition of the main variables for the four accounts that compose the DEII<br>- Definition of the interlink between DEII and Regional Maturity Grade methodology |
| **Work Packages** | This deliverable represent one of the outputs of Task 11.5 (WP11) and integrate the outputs of others tasks in the same WP, namely task 11.1, 11.3 and 11.4. It has been influenced, at theoretical level, by the work conducted in WP12 (especially D12.10 and D.12.8). |
| **Partners** | Partners involved in DE local adoption can be interested in reading this deliverable, especially those of social science domain. They can be listed as follow: ITA, CAM, NUIM, Create-NET, IITK and NUR. |
| **Domains** | Social Science Domain. |
| **Targets** | This deliverable has two main targets: social scientist of social science domain inside and outside Opaals consortium and regional stakeholders interested in DE local adoption. With reference to the second target, this deliverable can be useful for local development agencies, intermediate actors (Chambers of Commerce, entrepreneurial associations, local research groups and consultants) and policy-makers especially. |
| **Publications*** | The work here reported has not been yet published. |
| **PhD Students*** | None |
| **Outstanding features*** | The deliverable increments the knowledge about DE adoption by providing a methodological framework for analysing the process of DE adoption that is here further modelled. Beside this, it adapts socio/economic impact analysis methodologies to the DE research field. The work has been noted and positively welcomed by DEN4DEk project partners that represent one of the target of this research outside Opaals consortium. |
| **Disciplinary domains of authors*** | Antonella Passani, Filippo Pennesi, Lorena Rivera-Leon: Social Science Domain |

*The information marked with an asterisk (*) is provided in order to address Recommendation n. 4 from the Year 2 review report*

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# Executive Summary

In the closure of OPAALS Phase II, and after many theoretical deliberations had emerged within the Project research community, Phase III is calling for the dissemination of the DEs concept outside the project community. Reaching policy-makers and relevant stake-holders with the aim of introducing the DE concept and promote the planning of their adoption at the regional level has always been one of the main objectives of the Cluster of Projects on Digital Ecosystems. Nevertheless, the introduction of the concept to relevant stake-holders is not an easy task, especially because DEs are rather an intangible concept and most of the times in order to justify investments, policy-makers need to understand the potential benefits and demonstrate results.

Limited resources, together with increasing practical questions about the financial, social and economic impact of DEs had revealed the need for an impact assessment and evaluation tool related to DEs local adoption.
This deliverable - based on the previous D11.1 (chapter 5) - represents a step forward in the definition of a Digital Ecosystem Impact Index. The methodology here described wishes to offer a flexible and adaptable approach to DE adoption planning and evaluation. The Digital Ecosystem Impact Index is meant to serve as a tool for 'evidence-based' policies formulation and can be seen as a mix between impact analysis and assessment evaluation.

In the first chapter we recap the research process of task 11.5 and we synthesise the hypotheses behind the DEII development; we offer a framework for DE territorial adoption process and we describe the relationship between the DEII and the Regional Maturity Grade methodology. The second chapter is dedicated to the main economical methodologies used in building the DEII and DE's users are defined.
Chapter three represents the core of the deliverable and it is dedicated to the description of the four accounts that form the DEII: financial account, Economic Development Account, Social Account and Users Account. For each account variables and indicators are presented.
Finally, in the conclusion section, we delineate main research questions that will guide phase three research and the methodological challenges that are still open.

## Introduction

This deliverable takes the steps from Chapter 5 of D.11.1 "A Research Agenda for bridging Digital Ecosystems to regional development and innovation in the Knowledge Economy". In D11.1 we delineate a research agenda for the development of Digital Ecosystem Impact Index as a methodology able to support policy makers in understanding the role that DE paradigm can play in local development. In this deliverable we will better specify the utility of such a methodology for evidence-based policy-making (chapter 1), we will describe the methodological background of the DEII (chapter 2) and we will then build the four accounts that constitutes its core (chapter 3). As we will see, the DEII methodology takes advantage of the research outputs of other colleagues in Opaals consortium: the deliverable take advantage of the work done in task 11.1, task 11.4 and task 11.5.

Before we enter in depth with the description of DEII, we would like to take in consideration the second year review comments related to task 11.5 in order to describe how this deliverable may answer to them.

With reference to chapter 5 of D.11.1 the reviewers stated: "*Chapter 5 is the most ambitious, proposing the development of a DE Impact Index that would measure in how far a DE would affect the socio-economic system in which it is deployed. However, this aim seems too ambitious in the present stage, where there is as yet no integrated theoretical framework to define what a DE is, and what it is precisely supposed to achieve. Moreover, as the chapter notes, there are as yet no clear cases of fully deployed DEs. This means that even if it were clear what impact to expect, there would not be sufficient empirical data to assess whether that impact was actually realised. The reviewers recommend postponing the development of such an impact index until a better understanding of DEs is achieved, via both a continuing theoretical development and a more in-depth investigation of well-chosen concrete cases".*

The researchers recognised that it is relatively early in Digital Ecosystems research to test and fine-tune an impact assessment methodology where there are no strong cases of deployment to verify, test and compare with. But they also recognised that the theoretical work could continue in order to provide the consortium and the policy-makers with a methodological framework ready to be tested once the existence of a strong deployment case materialises (Phase III). Such a strong use case has been recognised in the test that ITA will carry on in phase three by involving local SMEs. In addition, IITK experience with agropedia, already provided some interesting data, that could be used in phase three for testing the methodology (see Sarkar, R. and others, 2009a and Sarkar, R. and others, 2008b). Even if remaining at the theoretical level, the framework definition asks for in depth research that arose to be more demanding then expected. The DEII, in fact, is believed to be an important tool, able to develop a better understanding of the importance of a socio-economic perspective in Digital Ecosystems research. It is important to underline that the methodological framework proposed, as the majority of the impact methodologies, is useful for policy-makers also as a "strategy-definition" support tool. As described in D. 11.1, the DEII is meant to be not only an instrument to quantify the effective impacts of DE implementation (this for sure needs real and well established DE implementation at local level), but also as an instrument able to support policy makers in their information needs related to the DE adoption. In this sense, the DEII would represent a complementary tool to the Regional Maturity Grade, which had been developed by CENSIS[1] during the DBE project (Passani, 2005a) and further developed and tested by T6 ECO (Passani and Giorgetti, 2008). Such a methodology has been successfully used in the Lazio region and can give support to other policy-makers in developing policies able to support the DE implementation and, more generally, local sustainable development. Both TMG and DEII have been presented by T6 at a DEN4DEK project meeting held in Zaragoza last March and in an international workshop in Rome and then further disseminate trough the consortium (see www.den4dek.net/community). DEN4DEK partners (mainly regional representative interested in the local deployment of the DE) showed vivid interest in the methodologies and envisaged their utility. This supported the researchers in the interest of continuing this research activity, even if only at theoretical level.

[1] CENSIS (CENtro Studi Investimenti Sociali) is one of the main private research center based in Italy, see www.censis.it

Consequently, in this deliverable the DEII is seen, primarily but not exclusively, as a methodology able to support policy-makers in answering the following questions:

- "how can I monitor my investment in DE adoption?"
- "how can I evaluate the process of DE adoption?"

In this sense the methodology will offer a flexible and adaptable approach to DE adoption planning and evaluation. When we will have concrete case of DE adoption at local level (in Aragon, for example) we will be able to test the DEII and provide police makers - hopefully – with answers to another crucial question: "what will be the return of investment in DE adoption in term of socio-economic growth and innovation?" In this regard, in phase three, we will finalise the theoretical development of DEII updating it in order to keep it aligned with DE research and we'll then integrate it in a "Adoption step by step guide". Such a guide, which title and specific characteristics will be delineated soon, will summarise and operationalise all the socio-economic methods useful for policy-makers in their approach to DE adoption. DEII will become, therefore, part of a toolkit ready to be adapted and used at local level by all the stake-holders interested in DE adoption.

### Hypotheses behind DEII

Considering the definition of DE provided in D12.10 and the epistemological framework provided in the same deliverable, it is possible to draft the hypotheses that are behind DEII. Coherently to the meta-theory expressed in D12.10 the following hypotheses are useful in order to provide the condition for a falsification in the way it Popper (2002) defines. In other terms, the following hypotheses represent the expected impact of DE adoption at local level and the DEII is the methodological tool aiming to empirically test such hypothesis:

- DE will have an impact at local level
- The impact of DE adoption at local level will be different for different categories of users (see paragraph 2.2)
- The impact of DE adoption will be economical at micro and macro level and social
- Participating in the DE will be financially sustainable for the users
- DE will positively impact on the SMEs competitiveness
- DE will have a specific and positive impact in term of user's knowledge sharing possibilities and capabilities
- DE will have a specific positive impact in term of users' social capital
- DE will have a specific impact in term on modifying/reducing power asymmetries related to knowledge sharing
- DE will have an impact in term of ICT diffusion among SMEs and selected users and will multiply the ICT services available at territorial level

In the following chapter we will define a possible patter for DE adoption at local level and we will summarise the Regional Maturity Grade methodology, here understood as a complementary method to DEII. The logic behind the chapters structure is synthesised in the figure below (fig.2) that keep track of the dependencies among this deliverable and other Opaals research outputs.

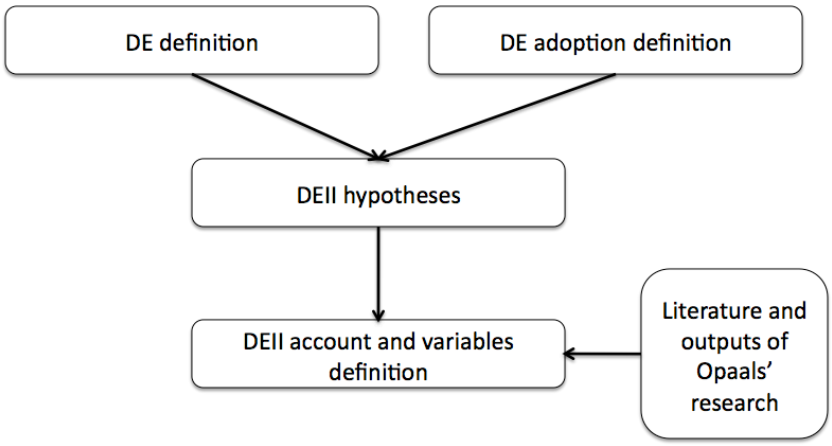


**Fig.1 - Deliverable structure logic and dependencies**

## Chapter 1. How socio-economic based methodologies can support DE territorial adoption

The Digital Ecosystem Impact Index is meant to serve as a tool for 'evidence-based' policies formulation and can be seen as a mix between impact analysis and assessment evaluation. Impact studies, in fact, aim to measure the reactions of the stake-holders and the outputs generated by them relative to a project, and also the proportion of any change attributable to the studied project. Evaluation assessment, moreover, is a periodic assessment of the relevance, performance, efficiency and impact of a specific project in the context of its stated objectives (Casley and Kumar, 1987).
As stated in D11.1 it is possible to envisage three possible uses of DEII (Henke, 2000):

- Instrumental use
- Conceptual use
- Warning

The *instrumental approach to* DEII will imply its usage as a method for mapping costs and benefits of DE adoption at local level (or after the DE adoption for measuring its impacts) and will be possible only when local stakeholders will be aware of DE concept and will have reached a preliminary consensus upon the possible investment to be made for adopting DE (main users should have been selected as well). As we will see, in this sense the DEII can follows the Regional Maturity Grade method in order to have a clear view on local players to be involved, and real cost to be met.
The *conceptual approach* to DEII will introduce at local level ideas and theories that might influence the political agenda and discourse. In this sense the DEII is important for the hypotheses upon wish it is built; first of all, the idea that DE is a socio-technical process that will lead to regional development. DEII will be, then, used as a tool for scenario building able to tell to policy makers what to expect - in a more concrete way - from DE adoption.
The *warning approach* to DEII emphasized its assessment evaluation aspects and can be used as a monitoring tool in order to evaluate the DE adoption progress and give feedback on how to improve the process itself. Consequently, DEII will support policy-makers in detecting possible risks to be tackled in order to reach the planned goals.

Because as argued in D11.1, we embrace a socio-technical approach to DE adoption and we criticised 'technological determinism', there will be not just *an* (sole) impact related to DE adoption, but rather different impacts that are inherent to the socio-economic-policy framework of the region/territory of adoption and the selected users.
In this regard, it can be useful to summarise the process of DE local adoption, in order to situate the application and the utility of the DEII. The DE adoption model that follows can be seen as the synthesis between the research done during the DBE project (Passani, 2007b) and the experience of CREATE-net in Trento provinces (Botto, 2009)[2]. In D12.10 its genesis is described in a more detailed way.

### 1.1 DE local adoption process

The new DE adoption model has been developed with the aim of balancing the top-down and the bottom-up aspects of the previous models; the top-down nature of the first model (Passani, 2007b) is mitigated, and the local community (future users) gain a bigger role in the digital ecosystem definition process (Botto, 2009). The top-down element of digital ecosystem adoption, however, cannot be eliminated; due to the fact that digital ecosystem deployment at local level is indubitably a political action that needs to involve policy-makers and to be connected to the institutional process of innovation policy development (this is particularly true at the present stage of digital ecosystem technology development). The DE adoption process is now less linear and become more coherent with the socio-costructivistic and hermeneutic approach of DE theory (see D12.10). The process is visually represented in Fig. 2 and, leaving out the feedback mechanisms there represented, can be summarised in eleven steps.

[2] Please refer to D12.10 for the genesis of this model and the links with the previous ones.

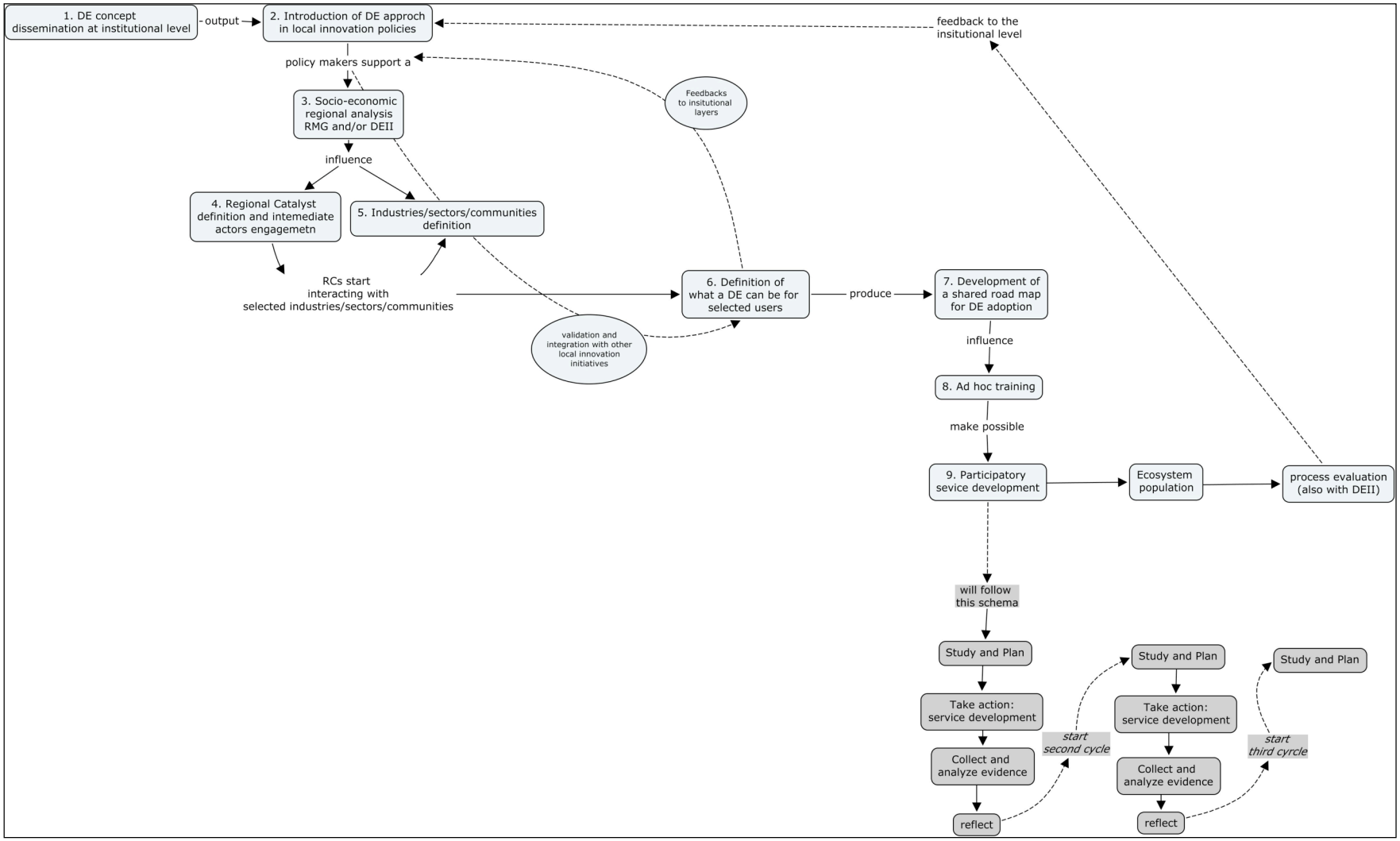


**Fig. 2 - DE adoption process**

The picture above synthesis the De adoption process in eleven steps, as follow:

1. DE concept dissemination at institutional level
2. Introduction of DE approach in local innovation policies
3. Socio-economic regional analysis (Regional Maturity Grade)
4. Regional catalyst definition and intermediate actors' engagement
5. Definition of sectors and communities of users
6. Definition of what a DE can mean for selected users
7. Development of a shared roadmap for DE adoption and services development
8. Ad hoc training
9. Participatory services development
10. Ecosystem population
11. Process evaluation

The DEII can be used repeatedly during the process of DE adoption (warning approach). From our point of view, however, it should be used in step 1 for planning the costs of DE adoption (conceptual approach), setting the goals (that have always to be coherent with the local needs) and acknowledge risk factors. At that stage it will be probably hard to have all the necessary data for the four accounts, but such an early usage of DEII (even with approximate data) can be of extreme relevance in order to use it as monitoring instrument and process evaluation tool. Between phase 6 and 7 when the beneficiaries of DE adoption will become clear, data for the four accounts can be properly gathered (instrumental approach). Variables related to user and social accounts will need to be better defined by adding sector dependent variables and make it more close to local specificities. Finally, in phase 11 DEII can be used in order to evaluate the DE adoption process as a whole (again instrumental approach). The evaluation will be of crucial relevance in expanding the DE and will influence the planning of new phases of adoption (for example in other sectors/industries/communities).

In order to support the complementarities between DEII and TMG some of the variables that form the TMG are also integrated in the DEII. In this way, the two instruments can be used at different time during the DE adoption process and the outputs can be - at least partially – compared.

### 1.2 Territorial Maturity Grade and DEII

The Territory Maturity Grade methodology is an actualisation of the Regional Maturity Grade method that has been developed by CENSIS during the DBE project (Passani, 2005a) and - in that context – has been used to benchmarking Aragon, Tampere and West Midlands regions' level of innovation and readiness to DE adoption. T6 Ecosystems has, then, further expanded this method applying it to different object of analysis (two provinces) renaming it Territorial Maturity Grade in order to stress the possibility to use it also in geographical entities other then formally recognised Regions (Passani and Giorgetti, 2008). The Territorial Maturity Grade (TMG) has been applied in two provinces of Lazio region (Rieti and Viterbo) in the context of a pilot introduction of DE in the touristic sector.

The aim of this methodology is to map the territorial situation from a socio-economic and innovation point of view before the DE adoption and evaluate territories' level of readiness to DE adoption. In this sense, it is a pre-requisite to DEII because it pictures the territorial situation at time zero. If we want to measure an impact (not in this research phase, but in the future) we need to know the situation on which DE is supposed to impact on. Beside this, TMG is extremely important in order to plan the supporting policies needed in order to make the DE adoption process feasible. Measuring the maturity of a territory to DE adoption tells to local stake-holders what is needed in order to enable the users/beneficiaries to effectively use the DE.

TMG synthesises the socio-economic characteristics of a territory in three macro-factors (Fig.3):

- Innovation capability
- Social capital
- Relationship between the SMEs and ICT

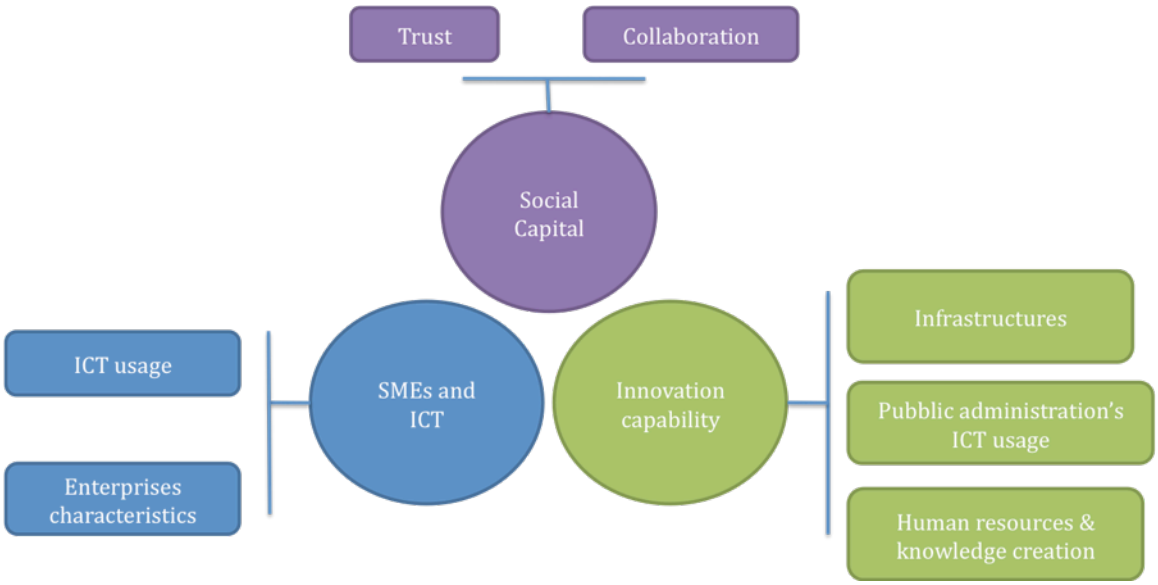


**Fig. 3 - Territorial Maturity Grade**

Each of these macro-factors is the sum of a series of variables (see Passani and Giorgetti, 2008 for variables' opearationalisation and specific data-gathering instruments). The TMG methodology takes advantage of existing statistical data and have been complemented with data from ad-hoc field studies surveys. Investigative instruments used in the study are mentioned in table 1.

**Social capital**

*Trust:* This indicator represents the trust perceived by the population of a certain territory towards the principle institutional and industrial intermediaries. A high level of trust corresponds to an elevated tendency of a territory to collaborate. This variable is useful in order to selected those local actors that - thanks to a high level of trust of the SMEs - can act as regional catalyst or facilitators.

*Collaboration*: A second aspect of Social Capital is expressed by the Capacity for Collaboration indicator that summarises the tendency to exchange information, collaborate and in general, operate in a network composed of different social actors. An elevated tendency towards collaboration between businesses is generally associated with a solid degree of trust and favours risk-sharing and joint planning for change management. Beside this, other values generated by a network analysis can be taken in consideration such as: Network density, Typology and Strength of links.

**Innovation capability:**

This axis indicates the variables, which are partly structural, on which the territory can rely on as catalysts towards continuing improvement. The capacity of a territory towards innovation is therefore interpreted as the articulation of diverse factors which are summarised in a series of synthetic indices:

Allocation of infrastructure; hardware and software
Characteristics of the human resources available in the territory and its level of knowledge generation
Usage of ICT in the Public Administration

*Allocation of Infrastructure:* This indicator summarises the effective level of infrastructure (heavy and light) present in the territory. A high infrastructure presence is considered indispensable for the socio-economic development of a determined territory.

*Characteristics of Human Resources and of the Generation of Knowledge:* A second macro indicator to assess the innovative capacity of a territory regards the quality of the human resources present locally. This indicator groups all those innovation indices generated from human resources, linking this factor of excellence to the capacity to generate innovative knowledge, which is manifested in activities such as the registering of patents, trademarks, inventions, etc.

*ICT in the Public Administrations:* To describe the capacity for innovation of a territory and its link to the digital ecosystems, innovative initiatives in the field of information technology in the region need to be highlighted. A third indicator is therefore that regarding the level of innovation of the ICT instruments used by the Public Administration. The inclusion of this variable is based on the recognition of the driving force effect that the public administration can have at a local level in the dissemination of ICT usage.

**Relationship between SMEs and ICT:**
*ICT in the SMEs:* This indicator is used to measure the degree of ICT usage in the small and medium sized enterprises, evaluating both the intensity (the frequency with which ICT technologies are used) and the amplitude (range of ICT instruments present in businesses). It is based from the CISCO steps of ICT adoption.
*Characteristics of the SME:* A second indicator is that which allows the characterisation of the SME in a particular territory, both on the basis of dimensions (micro small and medium, etc.) and their tendency towards innovation.

In the table below we summarise all the variables used in the TMG methodology, the source of data (when available) and the methodology used in order to gather data non available from official statistics.

| TMG axes | Variables | Indicators | Pre-existing Data Source | Methodology used for data gathering |
|---|---|---|---|---|
| **Social Capital** | | Trust | None | Interviews |
| | | Capacity of collaboration | None | Interviews |
| | | Network density | None | Interviews based network analysis |
| | | Typology and strength of links | None | Interviews based network analysis |
| **Innovation capability:** | *ICT in Public administration* | Presence of LAN | National statistical office | |
| | | Use of OSS | National statistical office | |
| | | n. of PC for 100 employees | National statistical office | |
| | | Level of ICT services provided | National survey (if available) | |
| | *Allocation of infrastructures* | Level of ICT infrastructures | National statistical office | |
| | | Level of economical infrastructures | National statistical office | |
| | | Railways and road infrastructures | National statistical office | |
| | *Characteristics of the human Resources and generation of knowledge* | Rate of unemployment | Eurostat and national statistical office | |
| | | Rate of employment in the service sector | Eurostat and national statistical office | |
| | | Presence of graduated and post-graduated | Eurostat and national statistical office | |
| | | Patent applications | Eurostat and national statistical office | |

| TMG axes | Variables | Indicators | Pre-existing Data Source | Methodology used for data gathering |
|---|---|---|---|---|
| **Relationship between SMEs and ICT** | *Characteristics of local enterprises* | Density | Statistical data (provided by the national statistical office) | |
| | | N. of small and medium enterprises | Statistical data (provided by the national statistical office) | |
| | | Number of micro enterprises | Statistical data (provided by the national statistical office) | |
| | | Number of enterprises in the ICT sector | Statistical data (provided by the national statistical office) | |
| | | Rate of entrepreneurial development | Statistical data (provided by the national statistical office) | |
| | *ICT in the SMEs* | Enterprises with website | None | Interviews |
| | | Enterprises with B2B services | None | Interviews |
| | | Enterprises with B2C services | None | Interviews |
| | | Enterprises using ICT for internal process management | None | Interviews |
| | | Business with CRM | None | Interviews |
| | | Business with SOA | None | Interviews |

**Table 1 - TMG variables, indicators and data gathering methods**

## Chapter 2. Building the Digital Ecosystems Impact Index: conceptual assumptions and methodologies

This Chapter introduces the methodological framework for building the Digital Ecosystems Index (DEII) and provides the definition of some core concepts. This chapter is the expansion of chapter 5 of D.11.1 and represent its actualisation.

DEs are a novel approach for the catalysis of sustainable development driven by networks of economic agents, enabled by ICT services and intelligent technologies that offer cooperative solutions that are affordable, trustworthy, adaptive and evolutionary.

Economists also commonly describe Digital Ecosystems as an enabler (tool) of development (Moore, 1996 and Nachira, 2007). From an economics empirical perspective, a DE is two things:

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

The latter definition requires further explanation. DEs minimise transaction costs within clusters at the regional/local level through knowledge integration and sharing within the regional/locality, and thus through more dynamic Regional Innovation Systems. DEs maximise the benefits to enterprises in participating to Global Value Chains because, when referring to SMEs and distributed markets, more collaboration leads to better competition.
The findings and results on deployment of the DBE project confirmed the above considerations that there are some differences in regional needs, requirements and opportunities for DEs. Typically, the regional variations reflect the differences in regional innovation capabilities, in regional enterprises' ICT capabilities, and in the characteristics of the social capital of the region/locality. 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 a DBE are characterised by:

- A strong focus on the development of the regional/local business sector
- 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 Open Source
- 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 in the 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. So far, five different typologies have been identified within a Regional Digital Ecosystem (RDE): Digital Business Ecosystems (DBEs), Digital Ecosystem for Public Administration (DE-PA), Digital Ecosystems for Researchers (or DEs of Knowledge – DEK), Digital Ecosystems for the Labour Market (or DEs of Work - DEW) and Community Network-like DE (CN-like DE). This last typology of DE makes reference to the work done in D. 7.1 (Botto e Passani, 2008) in which the possibility to engage grass-route initiatives and online communities to DE has been analyzed. The cross pollination between CN and DE is part of the ongoing experience of Trento province, which has been recently analyzed by Botto (2009).

Figure 4 is self-explanatory for understanding the possible co-existence of different DEs (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.

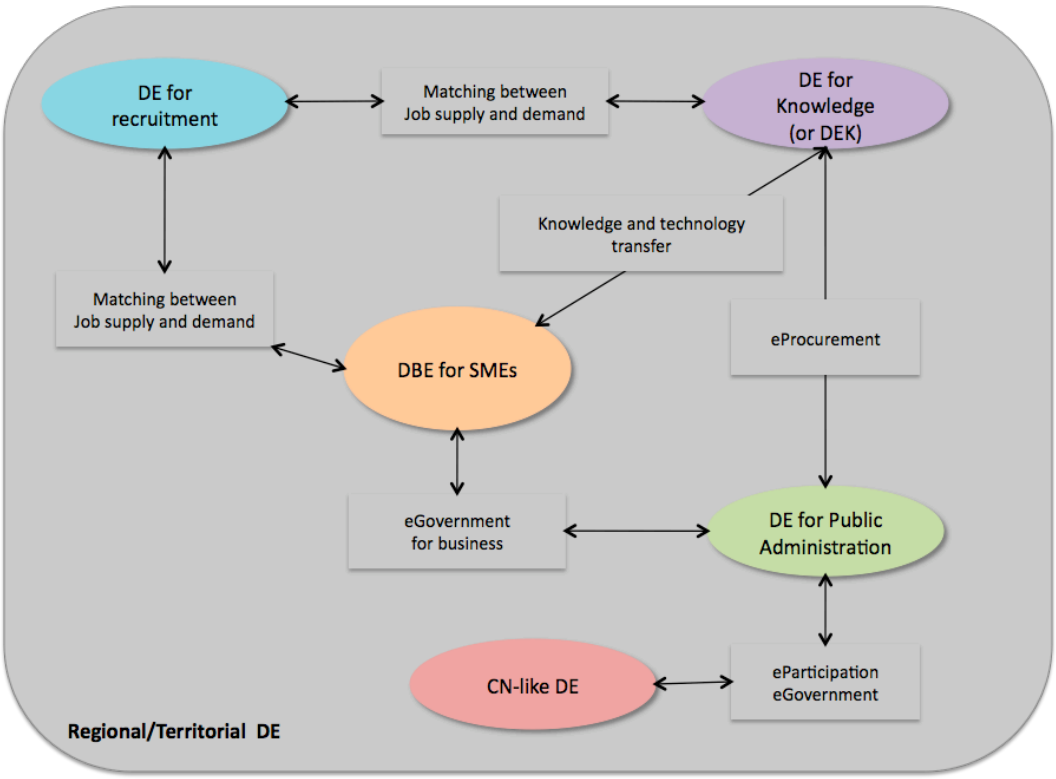


**Figure 4: A Regional Digital Ecosystem**

DE technologies are adaptable to different regional applications and needs, and they are thus not exclusive to the business sector; a good example in this sense is represented by the IITK experience in the agriculture sector. Each region has the opportunity to shape DE technologies to fit regional and local priorities best. In the context of impact evaluation, the first concern is to identify potential users and their needs for planning the deployment of DEs and thus for evaluating and assessing their impact. This exercise would help in setting a framework for methodology to meet those evaluation needs through the DEII.

## 2.2 Definition of DE users

In D11.1 a set of three groups of users was identified based on the above description of a RDE.

- Business Users. Mainly composed by the business sector, notably SMEs (differentiating by sector typologies) and including the communities of software developers in charge of developing the services and applications in the top of the DE platform.
- Knowledge Users. Mainly composed of universities, researchers and Knowledge creation and dissemination enablers (i.e. consultants).
- Strategic Users. Notably formed of public bodies (national, regional and local administrations), intermediate actors (chambers of commerce, development agencies, etc) and decision-makers.

As we have mentioned, the interlinks between different ecosystems (or habitats) may vary from context to context; consequently also the boundaries between users can vary accordingly. For example, an SMEs can interact with other SMEs in the DBE, but can (should) also be part of the DE for knowledge seeking for research's outputs or advices or, in some case, providing specific knowledge useful for researchers and other SMEs.

It is, then, important to understand what is the 'usage' that each of these groups would make of DEs in order to understand which impact the different typologies of DEs would have on the users and thus evaluate and assess these impacts through the DEII. The following table summarises the potential 'uses' that these groups would give to DEs within a RDA[3].

| Business Users | Knowledge Users | Strategic Users |
|---|---|---|
| - A networking virtual space<br>- A 'place' to easily offer and demand services and products. Better and more opportunities to compete and participate in marketplaces<br>- A 'tool' for accessing and participating in (global, regional and local) value chains<br>- A 'place' to access and use new and innovative solutions<br>- Access to new possibilities to develop better and new processes and thus achieving organisational changes<br>- A 'tool' for having more opportunities to innovate | - A networking virtual space<br>- A 'tool' for the promotion of knowledge and expertise embedded within local territories<br>- A space for collaborative knowledge creation and exchange | - In the case of general strategic 'uses' related to regional development<br>- A 'tool' for development of dynamic relationships of (economic and social) agents at the regional level<br>- Provision and access to 'next-generation' ICT infrastructures<br>- A 'tool' for higher adoption and diffusion of ICTs<br>- A 'tool' for the development of opportunities of better systemic integration between firms, academia and the public sector<br>- In the case of a DE-PE<br>- A 'tool' for the provision of digital services for businesses and citizens<br>- In the case of a DEW<br>- A 'tool' for better matching supply and demand in the labour market<br>- A 'tool' for making better and more efficient links of the working force<br>- A 'tool' for reducing unemployment rates and under-employment rates |

**Table 2: Potential 'uses' of a RDE per user group**

The needs and uses of the distinct user typologies will require different approaches and different types of data on impact. The main objective will be to assess whether deploying DEs has been worthwhile under two perspectives, in terms of the achievement of objectives of the DEs deployment as a project, and in comparison with the opportunity costs associated with that investment.

For the purpose of DEII development, this users categorization can be sufficient (a more articulated one may over complicate the aggregated index); however we have to remember that this represent an high level abstraction useful for methodological purpose. Beside this macro-definition of users, in fact, a detailed analysis of the concrete users of the DE should be done. In this sense the work carried on by NUIM team about the biotech and media clusters in Ireland (D11.2) is a good example. Another one being the work done by IITK with agropedia users (D11.4). In both cases the concrete needs of the users have been carefully analysed, in this way providing crucial information for the actual planning of DE services.

[3] As highlighted in chapter 1, a crucial step in DE adoption is that of defining the meaning that concrete users will give to DE, their expectations and, consequently, their envisaged use of DE (Cfr. Botto, 2009).

## 2.3 Main methodological approaches to be used in DEII

The Digital Ecosystems Impact Index is an aggregated composite indicator, formed of four evaluation accounts: financial, user, economic development and social.
It shares 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)

**Impact Assessment**
Impact assessment has been already introduced in D11.1 (Van Egeraat and others, 2008), consequently the attention of this chapter will be mainly dedicated to the second and the third methodology listed above. Nevertheless, on the basis of what is set out in D11.1 it is important to remember that the DEII will be built upon a bottom-up approach of DEs impact assessment, in its broadest sense. Assessing socio-economic impact of DEs requires both qualitative and quantitative measurement. The DEII will integrate qualitative and quantitative information and data. This is because socio-economic impact assessment is related to the valuation of costs, risks and benefits of tangible and intangible goods and assets[4].
The methodology will be looking at the micro and macro levels in its four evaluation accounts. From micro analysis the DEII will look for evidence on how DE inputs to innovation affect competitiveness and economic performance, all this mainly through the User/Consumer Account. From the macro-economic analysis, it will rely on the Economic Development Account, and to some extent on the Social Account. The micro-to-macro mechanism will allow driving policy conclusions and implications, and will facilitate the tracking of public policy challenges. In order to make the DEII more sensible to local specificities and to support its scalability the sensitivity and risk analysis methods have been added to the original methodological framework.

**Value Network Analysis**
With reference to Value Network Analysis we can say it is possible to follow this methodology for understanding, using, visualizing, optimizing complex economic ecosystems. The methods include visualizing sets of relationships from a dynamic whole systems perspective. Robust network analysis approaches are used for understanding value conversion of financial and non-financial assets.
In building the DEII we have also to consider the complexity of evaluating tangible and intangible goods. Assessing socio-economic impact of DEs requires both qualitative and quantitative measurement. This is because socio-economic impact assessment is related to the valuation of costs, risks and benefits of tangible and intangible goods and assets. Tangible goods and assets can normally receive monetary valuations (i.e. Financial Account and some components of the Economic Development Account in the DEII). Nevertheless, monetary valuations can rarely be applied to intangible goods and assets (i.e. Social Account and User Account). Value Network Analysis suggests deriving qualitative measures for them (Allee, 2002:12). Although in methodological terms quantitative data will not be directly comparable with qualitative data, the indicator will provide a picture of tangible and intangible trade-offs occurring in a given situation.

**Multiple Account Cost- Benefit Analysis**
Cost- Benefit Analysis calls for 'Impact Statements' to explain qualitative effects and trade-offs that are impossible to measure and/or are subject to large errors while being measured (Campbell et.al., 2003)
Considering Cost-Benefit Analysis (CBA), it does not focus on estimated impacts, but on the value and opportunity costs of what is produced. CBA looks at "what society gains and loses as a result of undertaking a project" (Shaffer et.al., 2003:4). It is a systematic framework to analyse the efficiency of projects, programs, policies and regulations (Munford et.al., 2000:79,80).

4 The complex relationship between the concept of 'impact' and Opaals theoretical framework, has been already analyised in D 11.1. Coherently with what has ben stated in D11.1 we do not intend impact assesment as a linear process, but to the contrary as a multifaceted, dynamic and contex-specific process (see Van Egeraat and others, 2008).

Economic efficiency is at its core. Its aim is to address the question on what the net balance would be between economic, financial and social benefits of projects implementation. CBA's premise is that resources are limited, not free (i.e. distinguishing between more and less valuable or efficient use of resources) (Shaffer et.al., 2003:7,8).

In the framework of the DEII, we are going to weigh a multiple-account CBA global methodological approach, as it would be wrong to refer to the DEII as a pure CBA exercise, because this one also entails some limitations.
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 from DE adoption, are from different prospective and for different stakeholders.

These steps are necessary requirements for a multiple-account cost-benefit analysis.
Financial analysis
Economic analysis
Sensitivity and risk analysis

**Financial analysis**
The main purpose of the financial analysis is to compute the project's (DE adoption) financial performance indicators. The methodology to be used is discounted cash flow (DCF) analysis.
This implies some assumptions (see European Commission 2008, Regional Policy):
- only cash inflows and outflows are considered (depreciation, reserves and other accounting items which do not correspond to actual flows are disregarded);
- the determination of the project cash flows should be based on the incremental approach, i.e. on the basis of the differences in the costs and benefits between the scenario with the project (do-something alternative) and the counterfactual scenario without the project;
- the aggregation of cash flows occurring during different years requires the adoption of an appropriate financial discount rate in order to calculate the present value of the future cash flows.
- cash flows must be considered in the year in which they occur and over a given reference period. When the actual economically useful life of the project exceeds the reference period considered, a residual value should also be taken into account. Ideally, this should be calculated as the present value of expected net cash-flows during the years of economic life outside the reference period.

The financial analysis should be carried out through subsequent, interlinked, accounts:
1. total investment costs
2. total operating costs and revenues
3. financial return on investment cost: FNPV(C) and FRR(C)
4. sources of financing
5. financial sustainability
6. financial return on the own capital: FNPV(K) and FRR(K).

The financial profitability of the investment can be assessed by estimating the financial net present value and the financial rate of return of the investment (FNPV/C and FRR/C). These indicators show the capacity of the net revenues to remunerate the investment costs, regardless of the way these are financed. Accordingly to EC, for a project to require the public funds, the FNPV/C should be negative and the FRR/C should thus be lower than the discount rate used for the analysis. In phase three, when DEII methodology will be finalized, we will be able to say if this assumption should be applied also to DE adoption, i.e. if a region should invest public funds only once this requirement is meet.
When computing the financial profitability of own capital (FNPV/K, FRR/K), the financial resources invested in the project are taken as outflows instead of the investment costs. Capital contributions should be considered at the moment they are actually paid out for the project or reimbursed (in the case of loans).

The financial sustainability of the project is assessed by checking that the cumulated (undiscounted) net cash flows are positive over the entire reference period considered. The net cash flows to be considered for this purpose should take into account investment costs, all financial resources and net revenues. The residual value is not taken into account here unless the asset is actually liquidated in the last year of analysis considered.

Financial analysis will be carried out with the various "economic entities" involved in the Digital Ecosystem. More specifically the financial analysis should be done from the point of view of SMEs interested in using DE and from the point of view of Public Administration. In fact, each user and each users typology (see paragraph 2.2) needs to analyse the financial profitability of adopting and participating in DE adoption process. The necessary data, will be gathered trough structured questionnaires and business audit.

**Economic analysis**

The economic analysis appraises the DE contribution to the economic welfare at local or regional level. It will be calculated from the point of view of the Strategic users (policy-makers and Public bodies) on behalf of the whole society.

The economic analysis, by mean of the definition of appropriate conversion factors, defines benefits and social costs not considered by the financial analysis.
The logic of methodology allowing the transfer from financial to economic analysis following these steps: it consists of the transformation of market prices used in the financial analysis into accounting prices (that amend prices distorted by market imperfections) and of the consideration of externalities leading to benefits and social costs unconsidered by the financial analysis as they do not generate actual money expenditures or income (for example redistributive effects).
This becomes possible by attribution of an ad-hoc conversion factor to change market prices into accounting prices (see European Commission 2006, Regional Policy).
The financial analysis cash flows are taken as the starting point of the economic analysis.
In determining the economic performance indicators for DE adoption, some adjustments need to be made, by mean of the definition of appropriate conversion factors for each of the inflow or outflow items.
Below the correction factors:

1: taxes/subsidies and other transfers corrections;
2: externalities corrections;
3: conversion of market prices into accounting prices to include also social costs and benefits (determination of conversion factors).

1: Fiscal corrections: indirect taxes (e.g. VAT), subsidies and pure transfer payments must be deducted. However, prices should be gross of direct taxes. Also, if specific indirect taxes/subsidies are intended to correct for externalities, then these should be included.

2: Corrections for externalities: some impacts may be generated that spill over from the project to other economic agents without any compensation. These effects can either be negative or positive. As, by definition, externalities occur without monetary compensation, these are not present in the financial analysis and therefore need to be estimated and valued.

3: From market to accounting (shadow) prices: besides fiscal distortions and externalities, other factors can drive prices away from a competitive market (i.e. efficient) equilibrium: trade barriers, labour regulation, incomplete information, etc. In all such cases, observed market (i.e. financial) prices are misleading; accounting (shadow) prices need to be used instead, reflecting inputs' opportunity costs. Accounting prices are computed by applying conversion factors to the financial prices.

After the correction of price/wage distortions and the choice of an appropriate social discount rate, it is possible to calculate the project's economic performance using the following indicators:

- economic net present value (ENPV): the difference between the discounted total social benefits and costs;
- economic internal rate of return (ERR): the rate that produces a zero value for the ENPV;
- B/C ratio, i.e. the ratio between discounted economic benefits and costs.

**Sensitivity and risk analysis**

Sensitivity analysis (SA) is the study of how the variation (uncertainty) in the output of a mathematical model be apportioned (qualitatively and/or quantitatively) to different sources of variation influences the input of a model. In more general terms uncertainty and sensitivity analyses investigate the robustness of a study when the study includes some form of mathematical modelling. While uncertainty analysis studies the overall uncertainty in the conclusions of the study, sensitivity analysis tries to identify what source of uncertainty weights more on the study's conclusions.
Risk analysis consists of studying the probability that a project will achieve a satisfying performance (in terms of IRR or NPV), as well as the variability of the result compared to the best estimate previously made. The recommended procedure for assessing risks is based on two main steps:

A. first step consists in a sensitivity analysis, that is the impact that assumed changes in the variables determining costs and benefits are seen to have on the financial and economic indices calculated;
B. a second step will be the study of probability distributions of selected variables and the calculation of the expected value of the project performance indicators.

A. These phases illustrate schematically the procedure that should be followed to conduct a Sensitivity analysis:

1. Identify all the variables used to calculate the output and input of the financial and economic analysis, grouping them together in homogeneous categories.
2. Identify possible deterministically dependent variables, which would give rise to distortions in the results and double counts. It will be necessary to eliminate the redundant variables, choosing the most significant, or to modify the model to eliminate internal dependencies. The variables considered must be as far as possible independent variables.
3. Carry out a qualitative analysis of the impact of the variables in order to select those that have marginal elasticity. The subsequent quantitative analysis can be limited to the more significant variables.
4. After Having chosen the significant variables, one can then evaluate their elasticity by making the calculations of the eco-financial indices (Saltelli, et al., European Commission, JRC of Ispra)

With reference to Risk probability analysis, once the critical variables have been identified, in order to conduct the risk analysis it is necessary to associate a probability distribution to each of them, defined in a precise range of values around the best estimate in order to calculate the evaluation indices. The probability distribution for each variable may be derived from different sources to be identified when applying DEII at local level (specialist literature on statistical inference).
Afterwards the probability distribution of the critical variables has been established, it is possible to proceed with the calculation of the probability distribution of the in eco-financial indices.
With the increasing complexity of the CBA model, even for few variables, very soon the number of combinations becomes too high for direct treatment; in this case it is possible to use the Montecarlo method, using the repeated random extraction of a set of values for the critical variables, taken within the respective defined intervals, and in calculating the performance indices (Tarantola, Saltelli et al. European Commission, JRC of Ispra).
The cumulated probability curve allows one to assign a degree of risk verifying whether the cumulated probability is higher or lower than a reference value that is considered to be critical.
In order to evaluate the result one very important aspect is the compromise to be made between high risk projects with high socio-economic benefits, on the one hand, and low risk projects with

low socio-economic benefits, on the other. There is sometime a priori reason to prefer neutrality to risk.

## Chapter 3 - The Digital Ecosystems Impact Index. Description of Accounts, variables and methodologies

The figure below schematises the DEII accounts that we will describe in details in the following paragraphs.

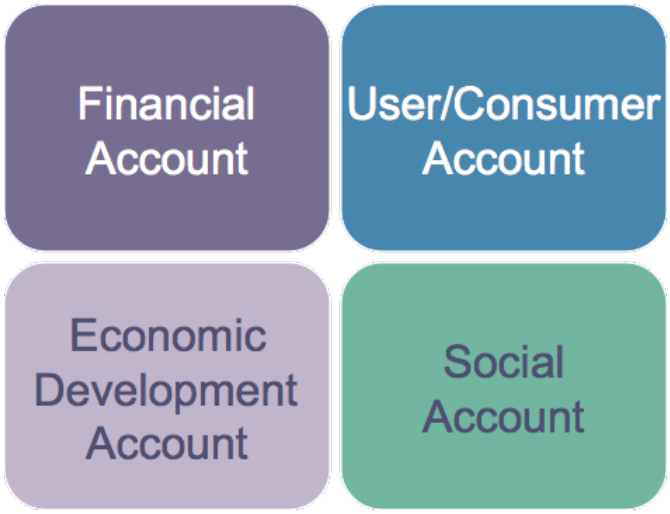


**Figure 5: DEII accounts**

Before doing so, it is important to clarify how different DE users can take advantage of DEII accounts. Generally speaking policy-makers and investors (strategic users) are going to be the main users of DEII; but Financial account and Users account can be useful instruments also for business and knowledge users as well. Those users, in fact, will need to carefully evaluate their net benefit in participating in DE adoption and should be sufficiently motivated - from a financial point of view - to undertake this innovative process. In this sense, the two above mentioned accounts (Financial and Users) are going to be used in a double sense in different time period.

### 3.1. Financial Account (FA)

The account looks at the expected revenues and expenditures coming from DE adoption. It aims to present the net financial costs of DEs adoption in order to determine if these are efficient from a public/private market perspective; and if the adoption is 'attractive' from the viewpoint of its financing stakeholders: i.e. business users, knowledge users and strategic users (as per Campbell et. al., 2003:2).

As previously mentioned in the financial analysis of Multiple Account Cost- Benefit methodology, different levels of financial costs are to be considered with regard to the DE adoption.
The first logical step in order to determine the financial account and relevant indicators is the estimation of how large the total investment cost will be. The investment outlays can be planned for several initial years and some non-routine maintenance and further technological development costs in more distant years. Thus we need to define a time horizon. By time horizon, we mean the maximum number of years for which forecasts are provided: the forecasts should be formulated for a period appropriate to its economically useful life and long enough to encompass its likely mid-to-long term impact.

The investment costs are classified (Rivera Leon, 2007) by:
- Fixed costs: including the Des infrastructures adaptation at local needs, research and Development activities (R&D) related to the infrastructure adaptation and service development.
- Variable costs: they comprise initial costs, setup costs, training and support costs. Socio-economic research related cost, consultancies cost, events and conference should be also included in variables costs.

The second step in financial analysis is the calculation of the total operating costs and revenues (if any). The operating costs comprise all the data on the disbursements foreseen for the purchase of goods and services, which are not of an investment nature since they are consumed within each accounting period.

In the case of DE adoption:
- Human resources costs, infrastructure maintenance and SMEs service integration.

The above mentioned costs have been investigated by one of the authors (Lorena Rivera Leon) during the DBE project and have been tested and quantified (for a more detailed analysis please see Rivera-Leon, 2007)

The FA will also look at who and how the DE deployment is financed, and how the source of funding affects the FA. The *who* finances the deployment, and its participation in total costs will vary according to the approach of finance and deployment to DE chosen by the region of deployment, but also by the sector chosen and the stage of the project (Shelton, 2006). The FA will also look at the effects and impacts that the different approaches of financing the deployment affect the financial risk. For instance, would the FA look different in the cases where DE is financed just by a private body/public body, through a Public-Private-Partnership (PPP), through an EU inter-regional cooperation scheme? Finally, higher financial costs might not necessarily imply cost-inefficiency, but the importance and engagement that the 'investors' give to innovation.

Having collected the data on investment costs, operating costs and revenues, the next logical step in the financial analysis is the evaluation of the financial return on investment.
The indicators needed for testing the project's financial performance are:

**Financial Net Present Value (FNPV),**
**Financial Internal Rate of Return (FRR).**
**Loan Life Cover Ratio (LLCR).**
**Profitability Index (PI)**

**Here below a synthetic description of the above mentioned indicators:**

The **financial net present value** (FNPV) is defined as the sum that results when the expected investment and operating costs of the project (suitably discounted) are deducted from the discounted value of the expected revenues:

$$\mathrm{NPV}\ (S) = \sum_{t=0}^{n} a_t\, S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \frac{S_n}{(1+i)^n}$$

Where $S_t$ is the balance of cash flow at time *t* and *at* is the financial discount factor chosen for discounting at time *t*

The NPV is the sum of $S_0 \ldots S_n$ weighted by the discount factor *at*, defined as: $a_t = 1 / (1+i)^t$ where *t* is the time between *0* and *n* (the time horizon) and *i* is the discount rate of reference.

The discount rate used in the financial analysis should reflect the opportunity cost of capital to the investor. This can be thought of as the foregone return on the best alternative project.

It has to be noted that when the discount rate is expressed in real terms, the analysis should be carried out at constant prices accordingly. If necessary, changes in relative prices need to be taken into account. If current prices are used instead, then a nominal discount rate must be employed.

The **financial internal rate of return** (FRR) is defined as the discount rate that produces a zero FNPV:

$$\mathrm{NPV}\,(S) = \sum_{t=0}^{n} S_t / (1+\mathrm{FRR})^t = 0$$

The calculation of the financial return on investment measures the capacity of the net revenues to remunerate the investment cost.

Considering the sources of financing we can identify different ones in order to calculate the total financial resources of DE adoption:
- European Community assistance (the EU grant);
- National public contribution (grants or capital subsidies at central, regional and local government level);
- National private capital (i.e. private equity under a PPP);
- Loans from different third parties

In case the fourth source of financing is involved, we have to envisage an essential indicator, which is:

The **Loan Life Cover Ratio** (LLCR) that evaluates the capability to refund debts following the amortisation plan. This ratio can be considered positive when its value is more than 1. It has to be calculated starting from the beginning of the refundable period

$$\sum n\ CFi/D_{res}$$

where $D_{res}$ represents the residual debt, up to the final timing of the amortisation plan.
We included here four different financial resources in order to make the DEII able to adapt at different DE adoption models. However, if we take in consideration only the DE adoption process presented in chapter 1 we can expect to have only the first two source of financing involved, at least in the take-off phase of DE adoption.

The **Profitability Index** (PI) attempts to identify the relationship between the costs and benefits of a proposed project through the use of a ratio calculated as:

$$\text{Profitability index} = \frac{\text{PV of future cash flows}}{\text{PV of initial investment}}$$

It identifies the relationship of investment to payoff of a proposed project, and it is a good tool for ranking projects because it allows us to clearly identify the amount of value created per unit of investment.
The table below synthesise the variables selected for the Financial Account and the methodologies to be used in gathering the necessary data. With reference to the methodology to be used for data gathering we mention ‘interviews’; of course, in order to use DEII at territorial level, we need to recognised not only ‘who’ we will need to interview, but also to clearly define the information needed and possible data sources. This will represent an important research activity in phase tree, when we will have the possibility to test – at least partially – the methodology. At the time of writing it is not efficient to define the methodology more in detail, in fact, the data gathering methodology is strongly depended from the context of DEII application. For example, if we think to use the DEII at national or regional level, we can have useful data from the European Central Bank; but if we use the DEII at sub-regional level we will need to find ad hoc data, an most probably directly interview the local authorities representatives.

| Account | Variables | Indicators | Pre-existing Data Source | Methodology used for data gathering |
|---|---|---|---|---|
| **Financial account** | *Discounted cash flow (DCF)* | Financial Net Present Value (FNPV) | None | Interviews |
| | | Financial Internal Rate of Return (FRR) | None | Interviews |
| | | Loan Life Cover Ratio (LLCR) | None | Interviews |
| | | Profitability Index (PI) | None | Interviews |

**Table 3 – Financial Account variables, indicators and data sources**

## 3.2 Economic Development Account (EDA)

The economic analysis appraises the DE contribution to the economic welfare at local or regional level, it looks - in other term - at the macroeconomic impacts and effects. The economic account is made by Public Bodies (strategic users) on behalf of the whole society and it looks - more then the other accounts - to the long period. In D11.1 we attributed to the economic account two level s of analysis: micro and macro impacts and effects. The literature review done afterwards suggested to separate the two and dedicated the economic development account only to the macro economic aspects of DE adoption. The micro economic aspects have been moved to the users' accounts. In this way, we also separate different data: mainly quantitative and numerical in the case of macro economic impact, and more qualitative in the case of the micro aspects of economic development.

With reference to the variables that follow, it is important to acknowledge that the possibility to observe an impact of DE adoption on those variables (macro-economic development) is a function of the number of users. Reaching a critical mass of users is a prerequisite to enable the visibility of benefits. Moreover, we cannot ignore the theoretical debate surrounding the macro-economic analyses of innovation processes. The available evidence at the macro-economic level, in fact, suggests that rapid development of ICTs (such as the one introducible through DE adoption) would have a significant positive effect on macroeconomics variables, such as productivity growth and outputs (see for example: EC, 2001b). Nevertheless, the magnitude of the impact is still subject to controversy. Macro-economic growth accounting exercises developed for the United States (US) demonstrate a clear link between ICT use and productivity gains, but the argument is not strong for all the sectors, including those sectors using ICT intensively (EC, 2001:252). Measurement errors are commonly argued to be the main reason for the understatement of the macro-economic potential of ICTs, however we must acknowledge that this field of research is not fully consolidated.
This exemplifies the difficulties in the measurement of macro-economic impacts of DEs, mainly because it is commonly argued that technological progress enabled by GPTs, such as the DEs, usually take several year for the wider benefits (on the macro-economy) to emerge (see IMF, 2001).

Before introducing more specific economic development variables, it is important to briefly describe the steps that need to be done in order to evaluate the DE adoption from an economic prospective in term of profitability and sustainability. The formulae that follow are the same used for the Financial Account (paragraph 3.1) but here the 'discounted total social benefits and costs' are introduced[5].

[5] The discounted total social benefits and costs here mentioned are going to be strongly linked with the outputs of the social account. The process of operationalization and interlink between the two account will be done in phase three, when a concrete case of DE adoption will be available.

After the correction of price/wage distortions and the choice of an appropriate social discount rate, it is possible to calculate the economic performance indicators:

**economic net present value (ENPV)**
**economic internal rate of return (ERR)**
**Benefit/Cost (B/C) ratio between discounted economic benefits and costs**

The ENPV is the most important and reliable social Cost Benefit Analysis (CBA) indicator and should be used as the main reference economic performance signal for project appraisal. Although ERR and B/C are meaningful because they are independent of the project size, they may sometimes involve problems. In particular cases, for example, the ERR may be multiple or not defined, while the B/C ratio may be affected by considering a given flow as either a benefit or a cost reduction.
On the contrary, there might be cases where the use of the benefit-cost ratio is appropriate, for example under capital budget constraints.
A synthetic definition of the indicators is presented below.

The **economic net present value** is defined the difference between the discounted total social benefits and costs

$$ENPV = \sum_{t=0}^{n} a_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \ldots + \frac{S_n}{(1+i)^n}$$

Where $S_t$ is the balance of cash flow at time $t$ and $a_t$ is the social discount rate for public sector investments chosen for discounting at time $t$

The NPV is the sum of $S_0 \ldots S_n$ weighted by the discount factor $a_t$, defined as: $a_t = 1 / (1+i)t$ where $t$ is the time between 0 and n (the time horizon) and $i$ is the discount rate of reference.

The economic internal rate of return (ERR) is the rate that produces a zero value for the ENPV.

The economic internal rate of return is the rate that produces a zero value for the ENPV.

$$0 = \sum \frac{St}{(1+ERR)^t}$$

The **Benefit/Cost ratio** (B/C) between discounted economic benefits and costs

$$\frac{B}{C} = \frac{PV(B)}{PV(C)}$$

The **B/C ratio** is the net present value of project benefits divided by the net present value of project costs. The ratio is accepted if the benefit-cost ratio is equal to or greater than one.
This ratio is used to measure both quantitative and qualitative factors since sometimes benefits and costs cannot be measured exclusively in financial terms. This ratio will be built in accordance with the variables defined in the social account.

With reference to the DE Economic profitability indicators (ENPV, ERR, B/C Ratio) they concern the financial direct benefits of DE adoption, in comparison with other projects that the Public bodies could finance. It will support public administration in analysing the economic sustainability and profitability of DE adoption. The variables that follow are, instead, more related to the benefits and the modification that the DE adoption will produce at local level, impacting on macro-economic variables. The problem of linking these two set of variables and operationalizing theme is one of the main challenge of Opaals' phase three. At the moment, without a concrete case of DE adoption

at local level, it is not possible, at least it will be not efficient, to go deeper in this important research field, that will be at the centre of our work in the next months.

In the following paragraphs, we analyse some indicators that can help us to understand how the DE adoption could have an impact at regional/ territorial macro-economic level: we use them in order to cover in depth the complexity of DE deployment, and to allow for an appropriate assessment of progress by providing ex ante, and ex-post evaluation.
In so doing, we have to remember that the introduction of the concept of sustainable development in recent policy-making has been a great impact on assessment methods. Eurostat has elaborated sustainable development indicators in order to use them to monitor the related policy process. The choice to use a policy-driven approach, i.e. to link directly indicators to policy priorities, gives a high visibility to statistics and indicators and ensures their full policy-relevance. It represents assessment tool needed for policy making in the field of sustainable development (see EU Sustainable Development Strategy, 2006).

Variables are aggregated by theme, adapting them from EU definition of Sustainable Development variables (http://ec.europa.eu/eurostat/sustainabledevelopment).

**Business development**

*Business investment - % of GDP*

Short Description: This indicator is defined as total gross fixed capital formation (GFCF) expressed as a percentage of GDP, for the private sector. GFCF consists of resident producers' acquisitions, less disposals, of fixed tangible or intangible assets, such as buildings, machinery and equipment, vehicles, or software. It also includes certain additions to the value of non-produced assets realised by productive activity, such as improvements to land. The ratio gives the share of GDP that is used by the private sector for investment (rather than being used for e.g. consumption).

*Business investment - Gross fixed capital formation by the private sector as a percentage of GDP*

Short Description: This indicator is defined as total gross fixed capital formation (GFCF) expressed as a percentage of GDP, for the private sector. GFCF consists of resident producers' acquisitions, less disposals, of fixed tangible or intangible assets, such as buildings, machinery and equipment, vehicles, or software. It also includes certain additions to the value of non-produced assets realised by productive activity, such as improvements to land. The ratio gives the share of GDP that is used by the private sector for investment (rather than being used for e.g. consumption).

*Business demography*

*Short Description: Business Demography contains information relating to business births (often referred to as business entries); business deaths (often referred to as business exits) and business survival rates. These variables are expressed as ratios of total businesses or businesses born in the reference period.*

**Innovation, ICT usage and competitiveness**

*Growth rate of labour productivity per hour worked - % change over previous year*

Short Description: Labour productivity per hour worked is calculated as real output (GDP measured in constant prices or chain-linked prices of previous year) per unit of labour input (measured by the total number of hours worked). Measuring labour productivity per hour worked provides a better picture of productivity developments in the economy than labour productivity per person employed, as it eliminates differences in the full time/part time composition of the workforce across countries and years.

*Total R&D expenditure - % of GDP*

Short Description: The indicator is defined as the percentage share of GERD (Gross domestic expenditure on R&D) in GDP. Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge.

*Turnover from innovation - % of total turnover*

Short Description: This indicator is defined as the ratio of turnover from products new to the enterprise and new to the market as a % of total turnover. It is based on the Community innovation survey and covers at least all enterprises with 10 or more employees. An innovation is a new or significantly improved product (good or service) introduced to the market or the introduction within an enterprise of a new or significantly improved process.

*ICT in the Public Administrations Index:*
Short Description: The level of ICT usage by the Public Administration can be important because, if it is high, can act as a driving force effect for the dissemination of ICT usage at local level. A the same time, we can expect that DE can impact on the capability of the Public administration of using ICT and ICT based services by introducing add hoc service for a better integration with the business word and with citizens in general (see Fig. 4: DE for Public administration). This index is based on the homonym index of the Regional maturity grade (paragraph 1.2) can be the composed by the following sub-indicators:

- Presence of LAN
- Use of OSS in the territory
- PC per 100 employees
- Number of e Government services

The database for this index is generally provided by national statistical offices.

*ICT usage by SME Index*
Short description: This index is used to measure the degree of ICT usage in enterprises, evaluating both the intensity (the frequency with which ICT technologies are used) and the amplitude (range of ICT instruments present in businesses). This index, that is an adapted version of the one used in the Regional Maturity Grade method (see paragraph 1.2) and is composed by the following sub-indicators:
- Percentage of enterprises that use Internet
- Percentage of enterprises that have web/home page
- Percentage of total number of persons employees using computer with their normal work routine
- Percentage of enterprises that have purchased products / services via the
- internet
- Percentage of enterprises that have received orders via the internet
- Percentage of enterprises whose IT systems for managing orders or purchases
- are linked automatically with other internal IT systems
- Percentage enterprises whose IT systems are linked automatically to IT systems
- of suppliers or customers outside their enterprise group
- Percentage of enterprises that have sold products to other enterprises via a
- presence on specialised internet market places

Data for the national dimension can be found in the eBusiness Readiness Index of the European Enterprise and Industry DG (http://ec.europa.eu/enterprise/ict/statistics/e-commerce.htm). In the report national source of data are described and regional data are normally provided at national level[6].

**Employment**
*Total employment rate - %*

Short Description: The employment rate is calculated by dividing the number of persons aged 15 to 64 in employment by the total population of the same age group. The indicator is based on the EU Labour Force Survey. The survey covers the entire population living in private households and

[6] Due to the fact that DE main users will be SMEs, we have to highlight a well known statistical problem; all the international statistics about enterprise take in consideration only those business units with more then 10 employees. This can represent a severe limitation of the data when working in territories, like most Italian regions, in which 90% of enterprises have less then 10 employes. For this reason we recommend to take in consideration also national and regional statistic report that may overcome this limitation. Otherwise ad ad hoc survey can be necessary.

excludes those in collective households such as boarding houses, halls of residence and hospitals. Employed population consists of those persons who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent.

*Dispersion of regional employment rates - Coefficient of variation of employment rates (of the age group 15-64) across provinces (NUTS level 3) within regions or across regions (NUT level 2)*

Short Description: The dispersion of provincial employment rates of the age group 15-64 shows the provincial differences in employment within regions and groups of countries (EU-25, euro area). The dispersion of regional employment rates evaluated, similarly, the differences among regions in the same country and across Europe. The employment rate of the age group 15-64 represents employed persons aged 15-64 as a percentage of the population of the same age group. The dispersion of provincial/regional employment rates is zero when the employment rates in all provinces/regions are identical, and it will rise if there is an increase in the differences between employment rates among provinces/regions. This indicator is not applicable in all EU countries and regions because of different definition of NUT2 and NUT 3 units of analyses, but if the scope of the analysis is not comparative national data are generally easily available in many EU countries.

The table below synthesise the variables selected for the Economic Account and the methodologies to be used in gathering the necessary data.

| Account | Variables | Indicators | Pre-existing Data Source | Methodology used for data gathering |
|---|---|---|---|---|
| **Economic Development account** | *DE Economic profitability* | Economic net present value (ENPV) | None | Interviews |
| | | Economic internal rate of return (ERR) | None | Interviews |
| | | B/C ratio between discounted economic benefits and costs | None | Interviews |
| | *Business development* | Business investment - % of GDP | Eurostat | |
| | | Business investment - Gross fixed capital formation by the private sector as a percentage of GDP | Eurostat | |
| | | Business demography | Eurostat | |
| | *Innovation, ICT usage and competitiveness* | Growth rate of labour productivity per hour worked - % change over previous year | Eurostat | |
| | | Total R&D expenditure - % of GDP | Eurostat | |
| | | Turnover from innovation - % of total turnover | Eurostat | |
| | | ICT in the Public Administration Index | National statistic office | |
| | | ICT usage by SMEs index | eBusiness readiness index report | |
| | *Employment* | Total employment rate - % | Eurostat | |
| | | Dispersion of regional employment rates - Coefficient of variation of employment rates (of the age group 15-64) across regions (NUTS 2 level) within countries | Eurostat | |

**Table 4 – Economic Account variables, indicators and data sources**

## 3.3 Social Account

As stated in D11.1, the social account looks at social and community impacts produced by DE adoption; in some sense it take in consideration the aggregated benefits of the users and it is complementary to the economic development account. For a policy-maker investing in DE, in fact, it can be of great interest to examine - as output of its investment – the benefits that the society as a whole will have beside the pure economic outputs. In this account, the intangible elements of the DE adoption play a crucial role and the link with the ontological definition of DE (see D12.10 - Dini and others, 2009) is evident. Concepts such as knowledge, power and democratic process, in fact, represent the essential backgrounds of the account.
The variables that composed this account have been at the core of extensive research in Opaals project, both at theoretical and at applied level: concept such as social capital, or knowledge exchange as a lever for local development have been studied - for example – by NUIM (D11.2) and IITK (D11.4, D11.5, D11.6) respectively. The description of the variables that follows generated by literature review and Opaals partners' deliverables and are here summarised for the support of the reader. With reference to data sources and data-gathering techniques for this account we make reference quite exclusively to ah hoc researches; in this regards the process of variables opearationalization need to be done case by case due to the fact that it will be highly dependent by the DE model that will adopted at local level and also by the typologies of users involved (see conclusions section). Many variables here listed have been already operationalised and used during DE related projects, but we cannot give it for granted do the above mentioned dependencies from local specificities.

*1. Social capital*

As Portes has stated, "an intrinsic characteristic of social capital is that it is relational. Whereas economic capital is in people's bank accounts and human capital is inside their heads, social capital inheres in the structure of their relationships. To possess social capital, a person must be related to others, and it is these others, not himself, who are the actual source of his or her advantage" (Portes, 1998). In short, social capital exists only when it is shared. But is not simply a matter of the extent to which people are connected to others, but the nature of those links. Social capital benefits grow together with the grow of network density. While social capital is relational, its influence is most profound when the interaction occurs between heterogeneous clusters. In this sense DE should impact on the possibility for the users to bridge the boundaries of their pre-existing network. This will be visible by looking at the density of the network that measures the overlapping between different typologies of networks. An extensive and detailed analysis of the literature on social capital and its economic potential impacts is out of the scope of this deliverable but can be fund in D11.5 (Sarkar and others, 2009).

In order to investigate the social capital variable the following indicators have been selected:
- Modification in the level of trust
- Modification in the capability to collaborate
- Modification in the numbers of interactions/social links
- Modification in network's density
- Modification in the typologies of social links
- Modification of the strength of social links

In term of data availability, as mentioned, we cannot rely on existing statistical data and had hoc research activities are needed. In the case of the first two variables, we can proceed with structured interview with questionnaires, in the case of the remaining variables we can use network analysis methodology based on face to face interviews. We already operationalized the above mentioned variables in a semi-structured interview during DBE project (Passani, 2005) and in Lazio region DE adoption pilot project (Passani e Giorgetti, 2008). Such operationalsed variables have been also used in the development of the EVESIM (Kurts and others, 2007). Another possibility is to gather the necessary data for the network analysis from the usage data of the DE technology itself by observing users online interactions.

*2. Access to knowledge*

- Variation in the number of knowledge/information providers
- Variation in the gab between information demand and information offer

Short description: we can define *knowledge/information providers* as the main points of reference for potential DE users; in other terms those are physical persons as well associations, institutions or immaterial source of knowledge (book, journals, online resources, etc) to which a potential user refers when looking for strategic information.
Similarly, the *gab between information demand and information offer* refer to the perception a potential DE user has about the information he needs and the possibility to acquire such information.
In order to gather the necessary data we need, once more, to rely on interviews. A possibility can be that of proposing a short questionnaire when a user access for the first time the DE and then contact him again in different time periods in order to evaluate if his capacity to access knowledge has been modify by DE usage. This is, however, only a hypothetical scenario about data-gathering techniques. As mentioned, we need to have a concrete case of DE adoption in order to better define data sources and data-gathering techniques.

*3. Knowledge production and sharing*

- Number of "piece of knowledge" generated and shared thanks to DE services.

Short description: The definition of 'piece of knowledge' is highly dependent from the nature that a DE will take at local level (fig.4), consequently it has to be defined case by case. For clarity, we can recall the definition of 'piece of knowledge' used by IITK with the agropedia DEK. In that case researcher took in consideration pages and definitions provided by experts as well as questions, answer and interaction provided by all the users in agrowiki, agro-blog, agro-forum and agro-chat like interaction spaces.

- Production and sharing of different typologies of knowledge base: synthetic, analytical and symbolic.

This indicator have been suggested by the reading of D11.2 in which the author Chis van Egeraat (2009), apply this categorisation to SMEs clusters and can be considered a qualitative specification of the previous one:

"The categories entail different mixes of tacit and codified knowledge, qualifications and skills required by organisations, as well as specific innovation challenges and pressures. [...] An analytical knowledge base refers to activities where scientific knowledge based on formal models and codification is highly important. [...] A synthetic knowledge base refers to activities where innovation takes place mainly through the application or novel combinations of existing knowledge. Often this occurs in response to the need to solve specific problems identified during the interaction with customers and suppliers. [...] The proponents relate symbolic knowledge to the aesthetic attributes of products, to the creation of designs and images and the economic use of various forms of cultural artefacts." (Chris van Egeraat, 2009 analysing the work by Asheim, Boschma and Cooke, 2007; Asheim, Coenen and Vang, 2006).

This indicator can be particularly interesting in analysing the impact of interaction among business users and between them and knowledge users. Which kind of knowledge do the users produce? What kind of knowledge are them more interested to share? This indicator will tell us which kind of knowledge is most shared tanks to DE and can also be useful in monitoring users' information needs. Moreover, different knowledge bases need different exchange settings and this indicator can orient the development of specific tools accordingly to the emergent necessities of the users.

| Account | Variables | Indicators | Pre-existing Data Source | Methodology used for data gathering |
|---|---|---|---|---|
| **Social account** | *Social Capital* | Modification in the level of trust | None | Interviews |
| | | Modification in the numbers of interactions/social links | None | Network analysis or quantitative data from DE technology usage |
| | | Modification in the network's density | None | Network analysis and/or quantitative data from DE technology usage |
| | | Modification in the typology of social links | None | Network analysis or quantitative data from DE technology usage |
| | *Access to Knowledge* | Modification in the gap between information need and information offer | None | Interviews |
| | | Variation in the Number of knowledge hubs (providers) | None | Interviews |
| | *Knowledge Production and Sharing* | Number of "piece of knowledge" generated and shared | None | Quantitative data from DE technology usage |
| | | Production and sharing of different typologies of knowledge base | None | Quantitative data from DE technology usage |

**Table 5 – Social Account variables, indicators and data sources**

## 3.4 User account

The account looks at the impacts (positive and negative) and the flow of net benefits of DE users as 'consumers' of what is provided by DE adoption. The account will consider the three typologies of users defined in paragraph 2.2 separately. In this way, coherently with what stated in D11.1 it will be possible to derive a differentiated and independent DEII by each DE user typology. Nevertheless, the account can also indicate global trade-offs for all of the identified DE users if the DE deployment is financed (as in he framework presented in 1.1) through regional partnerships, or directly by regional policy-makers, decision-makers or by the local/regional government. At the present stage, this account is the most complex to define because it is highly depended from the definition that the users themselves will give to the DE (Botto, 2009). In special way, for business and knowledge users the benefits and the impact will be also highly depended by the services that they will use in the DE. Consequently at the present stage of DE research we can only provide literature-based variables. Only when a concrete experience of DE adoption will be in place it will be possible to provide a better-defined version of the users account. In any case, a territory planning to adopt the DE, will need to carry on a specific customisation of this account involving the users in the definition of the expected impacts. The expected impact, in fact, is the main driving idea of this account. In Opaal phase three ITA use case will provide a first opportunity to proceed in this direction.

Before describing the variables of the user account, it is important to highlight that for Public Bodies and strategic users in general, the net benefit will be represented by the trade-off between the outputs of the Financial account on one side and the outputs of the Economic Development Account, the Social Account and Users account referred to business and knowledge users. With reference to strategic users, in fact, their willingness to participate in the DE - in the adoption framework used in this deliverable (paragraph 1.1) - is driven by the desire/necessity to develop their territories (see page 15).
We have, then, to remember that business and knowledge users will perform the financial account too. So their net benefit in using the DE (and its impact) will be based on the comparison between the financial account and the user account.

**Variables for strategic users**

As we said, for a strategic user the final benefit in introducing the DE in its territory will be represented by the output of the economic development account and that of social account, plus the benefits obtained by business and knowledge users. Beside this, the variable that follows can be introduced in order to evaluate a specific benefit that a strategic user could expect for the DE adoption:

*Territorial image and international co-operation*
When speaking about innovation at local level, we have to take in consideration that region – in a similar way of enterprises – do collaborate and compete at international level. A region willing to become more attractive for innovative business, for example, need not only to invest in infrastructure, human resources etc but also to reach a level of international recognition able to support its investment. In this aspiration a region can greatly benefits from collaborating with other regions that may offer the necessary know-how. Be part of international networks, in this sense, can be a positive externality of DE adoption (see DEN4DEK project as an example of this dynamic). At the same time, DE as socio-technical tool is meant to be international itself. Consequently for a regional public administration collaborating with other territories already implementing DE can have also a financial appeal: a service developed in a region can be transferred (or translated) in another region and the international community or research can offer the necessary know how lowering the investment cost of DE adoption.

Indicators for this variable can be the following:
- Variation in the number of international projects presented
- Variation in the number of international cluster participation (or agreements)
- Participation and organisation of international conferences
- Variation in quotation in national and international journals

The intangible nature of this assets[7] make the variables mainly qualitative and ask for ad hoc surveys.

**Variables for business users**

Business users will evaluate the financial profitability of using DE thanks to the financial account, then their will use the user account in order to evaluate the benefits and the impacts of its usage.
Variables for business users are divided in two macro categories: tangible and intangible. The intangible variables have a direct connection with the social account. In other terms, intangible benefits for business users can be sees as transposition of social impact at a micro level.

[7] In D.11.1 we included in the Social Account another variable: “Social inclusion, participation and quality of life”. This variable recall the ontological approach of DE theory and look at the effects of DE in term of democratic participation. At the time of writing it is difficult to develop this variable and include it in the DEII, however we can say that the variable “assess to knowledge” already cover some of the aspects related to democratic participation. Access knowledge is, in fact, a pre-requisite for participation. This variable becomes more and more important in CN-like DE in which one of the crucial aim of DE is to foster grass-root participation in the knowledge economy and territorial democratic process trough eParticipation services. This variable can be further developed in Opaals phase three. The e-Government Readiness Survey Report can be an interesting point of reference for this research, the data presented in the report are, unfortunately, only at national level.

*TANGIBLE*
- Modification in the turnover from B2B
- Modification in the number of client/supplier
- Variable costs' reduction due to organizational changes
- Modification in human recourses training costs

*INTANGIBLE*
- Modification in the social capital (please see paragraph 3.3 for the definition of variable)
- Modification in knowledge accesses (please see paragraph 3.3 for the definition of variable)
- ROI (Return on Influence) Is a quite new metric used for measuring (in social media) how much an individual or a brand can influence other members of a community. It tracks the capability of a user to obtain social recognition thanks to his participation in online social interactions. And as traditional ROI it measure the return of the investment made for entering a community or as in this case in the DE.
- ROS (Return on Skills) As the previous one, this is metric used in analysing online communities and it measure the modification (and the net benefit compared to the investment) in terms of new skills acquired by the user (the company). This variable will evaluate how the knowledge provided thanks to DE may impact in the organisational and 'how to' know how of the users.

**Variables for knowledge users**

In defining the uses of DE, we stated that for knowledge users DE will represent a place for networking, promote and disseminate knowledge and for collaborating knowledge creation.
From this definition and also from the experience of Opaals community approach to OKS we can propose the variables that follow as metrics for monitoring and evaluate the impact and the benefit of DE usage. In this, as in the case of business users, the connection with the social account is quite direct. Some variables are in common with the one presented for business users, and also in this case we can separate variables in tangible and intangible categories.

*TANGIBLE*
- Modification in academic production (articles, conferences, courses, etc)
- Modification in the number of projects, collaboration agreements and funds

*INTANGIBLE*
- Modification in the social capital (please see paragraph 3.3 for the definition of variable and its indicators). A special attention should be dedicated to the modification in the number of collaboration between research domain ad business domain.
- Modification in knowledge production and exchange (please see paragraph 3.3 for the definition of variable and its indicators)

ROI (Return on Influence) Is a quite new metric used for measuring (in social media) how much an individual or a brand can influence other members of a community. It tracks the capability of a user to obtain social recognition thanks to his participation in online social interactions. And as traditional ROI it measure the return of the investment made for entering a community or as in this case in the DE.
- ROS (Return on Skills) As the previous one, this is metric used in analysing online communities and it measure the modification (and the net benefit compared to the investment) in terms of new skills acquired by the user (the research or the research institution). This variable will evaluate how the knowledge provided and exchanged thanks to DE may impact on the researcher/research institution knowledge.

The table below synthesise the variables, the indicators and the data sources to be taken in consideration for the users account. As for the others accounts, when the data-set are not statistically available, a suggestion for methodologies useful for gathering data is proposed.

| User | Variables | Indicators | Pre-existing Data Source | Methodology used for data gathering |
|---|---|---|---|---|
| **Strategic users** | *Territorial image and international co-operation* | Variation in the number of international projects presented | None | Interviews |
| | | Variation in the number of international cluster participation (or agreements) | None | Interviews |
| | | Participation and organisation of international conferences | None | Interviews |
| | | Variation in quotation in national and international journals | None | Interviews and analysis of regional media coverage reports |
| **Business users** | *Tangible benefit/effect* | Modification in the turnover from B2B | None | Internal audit/ Interviews |
| | | Modification in the number of client/supplier | None | Internal audit/ Interviews |
| | | Variable cost reduction due to organizational changes | None | Internal audit/ Interviews |
| | | Modification in human recourses training costs | None | Internal audit/ Interviews |
| | *Intangible benefit/effects* | Modification in the social capital | None | Interviews and/or Quantitative data from DE technology usage |
| | | Modification in knowledge accesses) | None | Interviews and/or Quantitative data from DE technology usage |
| | | ROI (Return on Influence) | None | Interviews |
| | | ROS (Return on Skills) | None | Interviews |
| **Knowledge users** | *Tangible* | Modification in academic production | None | Interviews/audit |
| | | Modification in the number of projects, collaboration agreements and funds | | Interviews/audit |
| | *Intangible* | Modification in the social capital | None | Network analysis |
| | | Modification in knowledge production and exchange | None | Quantitative data from DE technology usage |
| | | ROI (Return on Influence) | None | Interviews and/or Quantitative data from DE technology usage |
| | | ROS (Return on Skills) | None | Interviews and/or Quantitative data from DE technology usage |

**Table 5 –Users Account variables, indicators and data sources**

## 3.5 Toward the construction of a composite indicator

Composite indicators (CIs) often play an explicit role in shaping the frame of thinking of policy actors by drawing attention to particular issues, identifying benchmark performances and trends, and helping to set policy priorities. Furthermore, compiling a multitude on individual indicators on complex issues into a single index, CIs often seem easier to interpret by policy makers, and the general public. Consequently, CIs are increasingly recognised as a tool for policy making and, especially, public communication on countries' relative performances in wide ranging fields

The construction and the evaluation of the DEII are made of several steps, the first of which is the sub-indicators data selection. A second step is to fill up probable missing data that could represent a problem, frequently encountered when many variables are involved. Three approaches for dealing with missing data are distinguished. The first one, case deletion, simply omits the missing records from the analysis. The other two approaches see the missing data as part of the analysis and therefore try to impute values through either single imputation (mean/median/mode substitution, regression imputation, expectation-maximisation imputation, etc.) or multiple imputations (like a Markov Chain Monte Carlo algorithm). In constructing the DEII we take care of selecting variables for which data are normally available at European level, for this allowing comparison among different territories. When data are not statistically available we indicated the methodologies that can used in order to gather ad hoc data and in phase three we will group and further develop those methods that have been used since the beginning of DE research and that can be of help in supporting the DE adoption process.
The third step is to decide upon the weighting scheme and to assign the weight's values. The indicators are next normalised using z-scores (i.e., standardised units of the number of standard deviations from the mean). A fourth step is the calculation of the DEII and the application of the Uncertainty analysis (UA) and the Sensitivity Analysis (SA) to check the quality of the DEII. The last step will need, of course, a concrete case of DE adoption. At the time of writing ITA use case to be developed in phase three seems the best candidate for the DEII trial. We will also take in consideration ITTK experience and will maintain constant contact with DEN4DEK partners in order to evaluate the possibility to test the DEII as a valid tool for DE adoption planning in the interested territories.

We are aware that a common problem in building composite indicators is how to properly assess the robustness of the message provided by the composite indicators given the plurality of perspectives expressed by the involved stake-holders (European Commission, 2002).
The experience shows that disputes over the appropriate method of establishing weights cannot be easily resolved. Cox et al. (1992) summarise the difficulties that are commonly encountered when proposing weights to combine indicators to a single measure, and conclude that many published weighting schemes are either arbitrary (e.g. based upon too complex multivariate methods) or unreliable

**Uncertainty analysis (UA) & Sensitivity analysis (SA)**
A synergic use of the uncertainty analysis and sensitivity analysis of the composite indicators has recently been applied to gauge the robustness of composite index and to increase its transparency (Saisana et al., 2005).
The uncertainty on the estimation of the DEII would include both the variability in the weights and the uncertainty deriving from the imputation of the missing data (see Saisana et al., 2005, Nardo et al. 2005).
Different sets of weights could be available using participatory approaches that include a number of experts in the test case (focus group).
The uncertainty by which the DEII values could be affected comes from the imputation of probable missing data.
At this step it is useful to use sensitivity analysis to quantify how much of the uncertainty in the index is due to the various imputations. The variance based techniques are model free techniques of SA.

The DEII may send misleading, non-robust policy messages if it is poorly constructed or misinterpreted. Therefore this kind of analysis needs to be performed in order to verify the appropriateness of the developed composite index (DEII).
In the last resort a combination of uncertainty and sensitivity analysis can help to gauge the robustness of the composite indicator and to increase its transparency.

## Conclusions

This deliverable is one of the main output of task 11.5 (WP 11) and is dedicated to the further development of a methodology - the Digital Ecosystem Impact Index – aiming to support police-makers and local stakeholders in planning, evaluate and analysing the impacts of DE adoption.
In the first chapter we recalled the research process of task 11.5 and we synthesised the hypotheses behind the DEII development. These hypotheses are complementary with the ones described in D12.10 (Dini and others, 2009) that are at a higher level of generalisation. In chapter one, we also delineated a framework for DE territorial adoption process and we describe the relationship between the DEII and the Regional Maturity Grade methodology.
In the second chapter main economical methodologies used in building the DEII are presented and a definition of DE's users is provided.
Chapter three represents the core of the deliverable and it is dedicated to the description of the four accounts that form the DEII: Financial Account, Economic Development Account, Social Account and Users Account. For each account variables and indicators are presented.
In this deliverable the DEII methodology has been defined mainly at theoretical level but at a lower level of abstraction of the one provided in D11.1. The necessity to remain at theoretical level is due to the fact that we do not have, at the time of writing, a concrete case of DE adoption ready to be used for testing the methodology. In phase three, however, we will be able to test – at least to a certain level – the DEII methodology in Aragon region, where ITA will engage SMEs in using the DE technological environment. ITA use case, together with IITK experience, can provide a first field for further operationalize the DEII variables. This is, in fact, one of the main challenges of our future research. In this deliverable we defined the variables that form the four accounts, and we indicated main data sources and data-gathering techniques, however this has been done at a certain level of abstraction. In phase three we will need to better define data sources and data-gathering techniques in order to transform the variables in concrete questions (and questionaiires) and numerical outputs. This will represent an important research activity in phase tree; at the time of writing it was not efficient to define the methodology more in details, in fact, the data-gathering methodology is strongly depended from the context of DEII application.
Beside this, another important research goal of phase three will be that of defining the internal relationships among variables. Some of them have been already recognised in this deliverable, but again, this will need to be further operationalzed and transformed in numerical (not necessarily financial) outputs.
Finally, we have to remember that the main target of task 11.5 is represented by local stakeholders, so we need to provide a user-friendly methodology. This can be done, first of all, by aggregating and make as coherent as possible, all the research methods used in DE related projects. In this deliverable a clear connection between the Territorial Maturity Grade method (TMG) and the DEII is provided. In phase three we will try to link DEII with other already tested method in order to provide local stakeholders with a sort of DE-adoption tool-kit able to support them in the process of DE planning, deployment and evaluation. The work to be carried on in phase three will take advantage of the participation of T6 ECO to DEN4DEK project; DEN4DEK partner's, in fact, already shown their interest for DEII and will be constantly updated about the methodology development. Their feedbacks will for sure support us in the finalization of the methodology itself.

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