OPAALS PROJECT

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

D11.1 – A Research Agenda for bridging Digital Ecosystems to regional development and innovation in the Knowledge Economy – Preliminary Report

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Short Description: A collection of Five Milestones produced by WP11 partners towards the integration of a common view on the theoretical deliberations that integrate the concept of Digital Ecosystems to regional development and regional policy. D11.1 delineates the research agendas and research plans of WP11 partners through the description of goals, methodologies, challenges and theoretical frameworks. The Deliverable is the first step towards linking the economics of development and policy-making with the current discussions developed within the OPAALS research community, dealing with practical concerns such as knowledge creation, sharing and protection; local innovative processes for sustainable development; social capital for economic development; and policies as enablers of local innovation processes.

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Work Packages	Links between this deliverable and other OPAALS WPs: • WP6 because of the description of the main methodologies that are going to be used by WP11 partners. • WP10 and WP12 because of Chapters 3 and 4 that offer the theoretical background of a DE-like environment under development in India. These could provide interesting insights for the OKS implementation. Additionnally, this Deliverable is useful in respect to the Deliverable's elaborations in DE research. • WP9 because of Chapter 5 that offers a first description of 'policy makers' as a target for communication and dissemination. • WP3 (task 3.6) because of the description of SMEs, SMEs clusters and their behaviours presented in Chapters 1 and 2.
Partners	LSE, IPTI, Create-Net, UI, BCU, UNI-Kassel
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Targets	The major targets of this deliverable are Social Science domain researchers, regional and local stakeholders, and policy makers. Additionally, computer science domain researchers could be interested in Chapters 1, 2, 3 and 4 especially related to users scenarios and knowledge creation/exchange/protection mechanisms. Natural science researchers could be interested in Chapter 5 that provides a preliminary connection between complexity theory and economics; as well as other connections between complexity theory, local innovation and knowledge creation/exchange.

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Executive summary

This deliverable is a collection of different Milestones, one per workpackge task, providing a complete view of the different research agendas that will lead the WP11 partners towards bridging the gap between Digital Ecosystem research and its usage at regional level in the frame of local innovation for the knowledge society.

Each chapter presents different, but interlinked research questions and challenges. It introduces the main theoretical points of reference and the methodologies to be used by authors in order to reach the various research objectives.

This deliverable is the first step towards the achievement of the general objective of the WP: *to connect the necessarily theoretical deliberations surrounding the Digital Ecosystems concept with the practical concerns of regional development policy in the context of the Knowledge Economy*. Some issues and topics have already emerged as crucial throughout this Deliverable. Among others, the importance of intangible factors such as social capital and knowledge exchange for local sustainable development; the necessity to associate quantitative and qualitative research methods in order to access the complexity of those socio-economic processes that are connected to local innovation; the necessity to approach the usage of ICT in the field of local innovation from a socio-technical perspective; etc,

These thematics represent the *fil rouge* between the presented Chapters. Convergence among Chapters is already recognisable even if full convergence is a long-term objective that will need further research exchanges and deeper analyses.

The content of the Deliverable is organised as follows:

Chapter one provides the theoretical framework and research design that will guide Task 11.1. The task explores and explains the social and spatial structures of knowledge flow and innovation among SMEs. One of the main research statements is that there are different pathways to successful innovation and that the social and spatial structures underlying these pathways vary by industrial sector. The chapter offers an in-depth review of economic of innovation literature linking the approach to its spatial dimension. Other research topics include knowledge flow, learning processes and innovation. The proposed research follows a case-study design. The case studies will take the form of “innovation biographies”, supporting researchers in tracing back the history/genealogy of particular innovation projects in two industrial sectors in Ireland: biotechnology and digital media. Data collection methods include face-to-face semi-structured interviews with relevant actors in companies and institutions and a search of secondary sources.

Chapter two presents a literature review on the main issues related to knowledge protection and diffusion. The Chapter describes the relevance of invention - and invention protection mechanisms – in determining the economic success of companies and territories. It describes the research Road Map of task 11.2 through the following central subjects:

- The European patent system and its working mechanisms; and
- Actual patents usage by SMEs and their attitude towards community based models of invention protection.

The research then emphasises on the economic history of the patent system in order to identify its switch points that might have important policy implications. Then the central research questions are defined, e.g. did the patent stimulate innovation progress? What is the relation between the classical patent system, Open licence models and the *nodal governance* model for influence and control over innovation in relation to the DE?

The second part of the Chapter describes the fieldwork methodology that will be used, based on a GTM approach, representing an adaption of Carmaz extension from Glaser’s seminal Grounded Theory Method, involving two innovative clusters: Peterborough environmental

industries and Greater Cambridge knowledge-based industries. The Chapter provides a milestone description of the clusters' backgrounds.

Chapter three focusses on the process of collective learning and knowledge creation/sharing that will take place within the Indian National Agriculture Innovation Program (NAIP). The NAIP project will develop a DE-like environment able to connect localised knowledge clusters and support a knowledge flow and knowledge spill-over among them. The Chapter describes the theoretical points of reference that will support the analysis of the NAIP project. Basic conceptual approaches under study are:

- Nonaka's Model of knowledge Creation and sharing;
- Social capital analysis;
- Communication network theory; and
- Actor network theory.

The field work will take advantage of the Grounded Theory Approach and the observation of the NAIP project dynamics will be focusing on multiple conceptual dimensions such as: Community of Practice, Community of scholarship, knowledge management systems (actor and network) and the time horizon.

Chapter four focusses, as the previous one, on the Indian agricultural sector innovation process, specifically on the Agropedia project that is developing a virtual space for aggregating and sharing explicit and tacit knowledge about agriculture. The Chapter describes the research background and process of Task 11.4 which, through Agropedia, will develop a theoretical framework for an anthropological understanding of the socio-digital space under development in India. The main goal is to compare two different ways of approaching knowledge creation and sharing - the 'paid for' one and the 'volunteer based' one – and to describe their inputs in terms of local innovation. In order to analyse the effectiveness of digital tools in a social development context the researchers will make extensive usage of the participant observation methodology and dialectic inquiry. The outputs of the observation activities will then be analysed thanks to the SAP-LAP paradigm. A preliminary description of dialectic inquiry and SAP-LAP paradigm is presented in the second part of the Chapter.

Chapter five analyses the difficulty in designing a straightforward path in connecting DEs research with the necessities and the priorities of local stakeholders. This difficulty is primarily due to the differences between the agendas and priorities of researchers and policymakers. In order to overcome this challenge the Chapter proposes a Road Map for the development of a qualitative/quantitative methodology designed to assess the possible socio-economic outputs, trade-offs and effects of DE implementation. The methodology aims to be a useful tool for 'evidence-base' policy making and, adjustable to different territories and implementation strategies. It will be modelled as an open, scalable and flexible instrument. The methodology here introduced is the Digital Ecosystem Impact Index (DEII), which is based on four Evaluation Accounts: Financial, User/Consumer, Economic Development and Social. From the theoretical viewpoint, the work presented tries to reconcile the concept of impact with the ecosystemic approach, pivoting on 'complexity economics' as the main point of reference. The Chapter also presents a methodological process for DEII development and test, involving actively researchers and regional stakeholders.

Preface

The general objective of WP11 is to develop a methodology that can bridge the necessarily theoretical deliberations surrounding the Digital Ecosystems concept with the practical concerns of regional development policy in the context of the Knowledge Economy. Research in WP11 is meant to bring the OPAALS community and outputs to the actual and possible uses of Digital Ecosystems (DEs) research by 'policy-makers'.

The central key-question that involves the development of more 'practical' deliberations of Digital Ecosystems (DEs) research is how can we translate OPAALS and DEs research in something of clear policy relevance? And more importantly, what does 'policy relevance' mean in the case of OPAALS and DEs research? Answering these key questions is far from easy. Policy relevance is generally in the eye of the beholder (Renaud, 2000:56). The meaning that is ascribed to 'policy relevance' will depend directly on the values and priorities of its users and 'developers', which in the case of WP11, will be among the interaction of the OPAALS and DEs research community and the 'policy-makers'. This interaction, as it will be explained in the following sections, is a highly complex and non-linear process.

However, for now three main topics of research can be recognised. These can be easily linked with the language and the priorities of local stakeholders:

- the role of collaboration in localised innovative processes;
- the role of knowledge production and sharing in supporting innovation and economic growth;
- the role of different approaches to knowledge protection and management in supporting innovation; and
- the possible support of research-based methodologies for policy-making activities.

The first three topics will offer policy makers theoretical and field-based evidence able to support them in taking decisions on local innovation strategies. The last one will offer an open and flexible methodological instrument (the Digital Ecosystem Impact Index) that will, in the best case, become a useful tool for those policy makers that are interested in implementing the DE in their territories.

The above-mentioned research topics were translated in five parallel but interlinked research activities, corresponding to the following research tasks:

- Task 11.1: Social and spatial structures of collaboration and innovation in the Knowledge Economy
- Task 11.2: The role of institutions and IPR schemes in supporting intentional and unintentional knowledge sharing
- Task 11.3: The knowledge creation process: structures of communication and collaboration among Actors in Indian agriculture
- Task 11.4: The Dialectics of applying the OPAALS framework as a social innovation network in a developing country
- Task 11.5: Multi-stakeholder policy framework for regional economic development through Digital Ecosystems[1].

This deliverable presents the research agenda of WP11's tasks, delineates the main research questions and challenges, offers a first literature review of each of them and describes the methodologies that are going to be used within the research activities.

[1] This task will be based on the development of a methodology that aims to measure through a quantitative and qualitative analysis the socio-economic impact of DE adoption at local/regional level

Each chapter offers a theory-based working plan of the five tasks. As it will be noticed - even in this preliminary work - an interesting high level of convergence between research interests, theoretical references and methodological approaches is shown.

Main keywords for this deliverable are: *knowledge-creation, knowledge-sharing; knowledge-protection; collaboration; socio-economic impact; local innovative process; sustainable development; SMEs clusters; social capital; qualitative methodologies; policies for local innovation.*

The Conclusion section highlights the interlinkages and dependencies amongst tasks and their inputs to the achievement of the final goal of delineating a multi-stakeholders policy framework for local innovation.

Chapter 1

Social and Spatial Structures of Collaboration and Innovation in the Knowledge Economy: Objectives, Methods and Theoretical Orientation[2]

In technical terms, a Digital Ecosystem is a self-organising digital infrastructure aimed at creating a digital environment for networked organisations that supports co-operation, knowledge sharing, the development of open and adaptive technologies and evolutionary business models (Nachira et al., 2007). It provides structures of communication and collaboration that can facilitate collective learning, knowledge flow and innovation across SMEs and other actors.

This fits well with recent work in studies of innovation, which emphasizes the collective, collaborative processes that underlie innovation. This shows that innovation processes are becoming increasingly complex, involving different types of knowledge. Individual firms can no longer rely on their internal sources of knowledge only. Instead additional knowledge needs to be accessed from external sources. These trends have been characterised as a transition towards 'open innovation' (Chesborough, 2003) and 'distributed knowledge networks' (Asheim, Boschma and Cooke, 2007).

In order to understand sustainable digital ecosystems of SMEs and the contribution they could make to competitiveness of SMEs and Regional Development we need to understand in depth the processes of knowledge flow and innovation. Task 11.1 sets out to explore and explain the social and spatial structures of knowledge flow and innovation among SMEs. The premise of the research is that there are varying pathways to successful innovation and that the social and spatial structures underlying these pathways vary by industrial sector. The Task will explore these ideas through a series of case studies of innovation projects in two industrial sectors in the Irish economy, biotechnology and digital media. These take the form of "innovation biographies", tracing back the history/genealogy of particular innovation projects. Such a qualitative micro-studies approach is novel and certainly unconventional. An analysis of topics studied in the EU Framework Programmes concludes that "what was most striking was that hardly any project focused on innovation processes in firms. Given the importance of innovation for economic and social change, and the role of firms in innovation, this must be seen as a glaring omission (Fagerberg (2006, p. 21)".

This Chapter provides the theoretical framework and research design that will guide Task 11.1. The first subsections present the theories and themes on which the study focuses. The final subsection outlines the research design.

1.1 Theoretical Framework

In T11.1 innovation is seen as the outcome of a variety of socio-spatial processes that shape which kinds of innovation take place, when and where they take place, what ownership forms are associated with them and how the innovation process itself mobilises different alliances and networks of actors and institutions. There is now a large body of literature and theory that deals with various aspects or themes of the social and spatial structures of knowledge flow and innovation. Task 11.1 focuses on a select number of theories that are deemed to be particularly relevant in the context of digital ecosystems. Although the social and spatial structures of knowledge flow and innovation are strongly integrated, the next to sub-sections deal with them separately. These are followed by a discussion of a set of sectoral characteristics that act as independent variables, shaping both the social and spatial structures of innovation projects.

[2] Chris Van Egeraat, Sean O'Riain, Aphra Kerr (NUIM)

1.1.1 Social structures

Analysts have emphasised for some time that learning and innovation by firms occur within a broader 'system of innovation' – the network of inter-firm relations, public institutions, occupational communities and other actors that surround any firm. Typically however, the emphasis has been on how these systems of innovation differ between nations (Lundval et al., 2002; Kim and Nelson, 2000).

A new body of research has demonstrated the importance of 'sectoral systems of innovation' in shaping innovation and growth, particularly in a 'knowledge economy' (Lundvall et al, 2002; Kim and Nelson, 2000; Malerba, 2003). Much technological learning occurs around specific products (Storper, 1997) and this 'product based technological learning' becomes the basis of sectoral systems. The key products within a sector become the focus of learning among a diverse group of economic actors – firms, workers, academics, research policy makers and others. These become crucial constitutive elements of 'business ecosystems', facilitating and shaping knowledge flows.

Sectoral and national systems of innovation interact and potentially complement each other – Michael Porter's famous 'clusters' are one attempt to explain economic growth through a focus on how sectoral and national institutions interlock to create virtuous circles of industrial development (see also Hollingsworth, 1994; Kitschelt, 1991).

Innovation is increasingly seen as emerging not only from the development and commercial application of science but from a set of frameworks of economic activity or 'worlds of production' (Storper, 1997). The learning economy consists not simply of one model of learning and innovation but of a set of different but coherent worlds of production. There is no single model of growth. Instead, there are many diverse frameworks in different industries, regions and countries, each with their own dynamics of learning and innovation. The worlds of production and innovation involve many actors - firm and non-firm, public and private, and more (Storper, 1997; Lundvall et al, 2002).

Research on innovation has typically placed the firm at the centre of the innovation process – although this has been challenged in recent times through discussions of networked firms, regional innovation networks (Saxenian, 1994 and 2006) and systems of innovation. It remains crucial to understand firm strategies for innovation and to analyse how firms organise themselves and mobilise elements in their environments (ecosystems) to engage in innovation (Amin and Cohendet, 2004). These can take a variety of forms that differ in highly significant ways. Lorenz and Valeyre (2006) for example, find that a variety of forms of organisational learning and innovation exist – lean and learning models emerge alongside existing models of Taylorist and direct control within firms. They find that these models of firm learning are systematically related to different patterns of innovation, patenting and other outcomes as well as to different sectoral and national institutions. Recent studies of firms have therefore become concerned with how firms forge interdependencies (traded/formal and untraded/informal) with other firms in their ecosystem, how firm strategies are themselves shaped by the dynamics of these inter-firm networks and how firms negotiate the rewards from innovation (Storper, 1997).

In addition, researchers are increasingly looking beyond firms and inter-firm networks to non-firm processes such as interpersonal networks, associations and public and other collective organisations (Saxenian, 2004) that are an important part of the broader worlds of production.

Some authors emphasise inter-personal ties and, in particular, the 'knowledge communities' that consist of person to person networks operating below and across the level of inter-firm networks. There are in fact classic studies, now somewhat neglected, of the intersection, or lack of intersection, between firm ties and worker ties – research that asks to what extent worker networks cut across firm boundaries, to what extent they are contained within them, and to what extent worker relations across firms are mediated through gatekeepers that

become 'entry points' into the networks within firms (Allen and Cooney, 1974). Research has also looked more closely at the form of organisation of these communities and networks beyond the firm, recognising that the structure of networks – and knowledge flows within them – will vary significantly according to whether the workers are organised through 'techie' networks, professionalised occupations, crafts, scientific disciplines, communities of practice (Lave and Wenger, 1991), epistemic communities (Haas, 1992) and so on.

But firms are also embedded within a different set of networks – the network of formal and semi-formal associations that are part of any sector and ecosystem. These can act as resources but also shape the innovation process. They include universities; public economic and industrial development agencies (Ó Riain, 2004; Block, 2008); professional, trade and industry associations; and commercial supporting firms (Saxenian, 1994). Research examines what role these different institutions play in each innovation coalition; what flows of information move between these institutions and the innovation coalition to which they are connected; how they facilitate (or do not facilitate) the movement of knowledge across and between innovation coalitions; how they promote new forms of knowledge or priorities within innovation coalitions.

All of these different institutions are seen as important in the regional economies literature, and particularly in the research on high-tech regions (e.g. Saxenian, 1994 on Silicon Valley). Their interactions with one another can come to form a kind of 'public space' within which innovation and learning can occur (Lester and Piore, 2006).

Increasingly researchers have sought to link these structural dimensions of innovation systems to the form that learning takes within the innovation process – including the importance of different modes of learning such as analysis and interpretation (Lester and Piore, 2006); the dynamic and path-dependent character of that learning across the innovation process (Powell et al 2005), and the negotiation of the meaning of innovation itself (Girard and Stark, 2002; Lester and Piore, 2006).

Learning and innovation in the knowledge economy can take a variety of forms (Lorenz and Lundvall, 2006; Lester and Piore, 2006). This variety of potential pathways to innovation and the social structures that sustain those pathways need to be examined.

1.1.2 Spatial Structures

The social aspects of innovation are crucially embedded in the spatial organisation of knowledge flow and innovation. In relation to this, since the mid-1980s the spatial cluster concept, along with related territorial concepts such as agglomeration, industrial districts and systems of innovation have attracted much interest from academics and policy-makers concerned with regional/national economic development. Indeed, innovative clusters have become a policy panacea for many governments and international agencies such as the OECD that see clusters as drivers for regional and national competitiveness and growth.

Several cluster advantages may underlie this enhanced competitiveness. One part of the academic literature has focussed on traditional agglomeration economies, notably the external economies of scale and efficiencies in the supply of inputs, services and the labour market. However, empirical research does not always find evidence for extensive local production linkages between firms in a sector, thereby undermining at least part of the argument. Another stream of the cluster literature has focussed on the knowledge flows and knowledge spillovers between local actors that are believed to support the process of localised learning and innovation. Contributions to a knowledge-based theory of spatial clustering typically interpret learning and innovation as interactive processes that involve an exchange of knowledge between firms and other actors (including universities and other research institutions). The idea is that proximitity in local clusters can lead to dense networks of communication and information linkages that support both intentional and unintentional knowledge flows.

Although remaining highly influential, these ideas are increasingly challenged by empirical studies that show that firms in even the most developed clusters are often highly dependent on non-local relations for their knowledge. Recent contributions to the knowledge-based theory of spatial clustering specifically incorporate the idea that firms in clusters depend on both local and non-local knowledge flows through 'local buzz' and 'global pipelines' (Bathelt et al., 2004; Gertler and Wolfe, 2006). Global pipelines enable local firms to overcome shortcomings in local knowledge by linking firms with important developments generated by non-local actors. This constitutes a move to a more complex view of a multi-scalar geography of knowledge and local clusters as nodes in global networks.

Notwithstanding the importance of these contributions there is still a very limited understanding of the relative importance of local and global knowledge flows in knowledge creation and innovation and of the extent to which different flows are sensitive to proximity. A better understanding is facilitated by distinguishing between different dimensions of proximity, different modes of knowledge exchange and different levels of intentionality of knowledge exchange.

As regards the dimensions, besides geographical proximity, there are several other dimensions of proximity (Torre and Gilly, 2000; Torre & Rallet 2005; Boschma 2005, Moodysson, 2007). Boschma (2005) applies a very comprehensive categorisation involving cognitive, organisational, social, institutional and geographical proximity. All these forms of proximity can facilitate interactive learning and innovation. Geographical proximity may facilitate knowledge flow but it is not a sufficient condition because knowledge flow and learning require at least cognitive proximity and in most cases a combination of dimensions is at play. Neither is geographical proximity a necessary condition because the non-geographical forms of proximity can act as substitutes for geographical proximity. The conceptualisation is complicated by the acknowledgement that geographical proximity may play a role in strengthening social, organisational, cognitive and institutional proximity (Boschma, 2005).

As regards modes of knowledge exchange, knowledge can be exchanged using different modes or media, including face-to-face, post, telephone, email, video-conferencing, Internet and intranet forums and digital ecosystems. The requirement of face-to-face communication tends to be related to geographical proximity of actors. However, innovations in communication technology, in conjunction with an increase in organisational proximity, have reduced the need for face-to-face contact in the exchange of knowledge, even in the context of detailed technical design issues (Mckinnon 1997; Torre & Rallet 2005; Van Egeraat and Jacobson, 2006). In addition, the face-to-face contact that is required is often only required for short periods and can often be satisfied via frequent long-distance travel and the seconding of research staff for extended periods of time (Van Egeraat and Jacobson, 2006, Arita and McCann, 2000) – this has been referred to as "temporary geographical proximity" (Torre & Rallet. 2005).

As regards intentionality, some knowledge flows are intentional while others are unintentional. Unintentional interaction (Oerlemans and Meeus, 2005) within a group of actors involves the acts of observation and comparison (Malmberg and Maskell, 2002). The unintentional knowledge flows and knowledge spillovers are believed to be particularly sensitive to proximity, both geographical and non-geographical. Social, cultural and institutional proximity are particularly important for unintentional knowledge flow. Geographical proximity is important because much (though not all) unintentional knowledge flow takes place during face-to-face events and because the non-geographical forms of proximity are augmented by geographical proximity.

The distinction between intentional and unintentional knowledge flow is closely related to the concept of "buzz" that is rapidly gaining popularity (Bathelt et al., 2004; Gertler and Wolfe, 2006). Asheim et al. (2006) argue that buzz has been defined in rather ambiguous ways and call for a more precise definition, distinguishing between buzz and face-to-face

communication. As such they present it as a different mode of communication and knowledge exchange. This is slightly problematic since the authors make the point that buzz is more efficiently transmitted in face-to-face contexts, thereby creating an overlap between the categories of modes of communication. Buzz and face-to-face are distinguished on various grounds but one of the main and clearest differentiating factor involves the level of intentionality of the flow. “Buzz refers to non-deliberate knowledge and information exchange propensities” (p.214) and “is predominantly about knowledge spillovers (p. 216).

The dimensions of geographical proximity, modes of knowledge exchange and levels of intentionality are clearly integrated concepts that can assist the analysis of spatial structures of innovation.

1.2 Sectoral Differences

The premise of the research is that there are varying pathways to successful innovation and that the socio-spatial structures underlying these pathways vary by industrial sector. These differences are the outcome of numerous technological, economic and social factors. The current research project of T11.1 focuses on the influence of a select number of these factors. These are here discussed under three, partly overlapping, headings: type of knowledge; central occupational groups and knowledge communities; and organisation of firms and markets.

1.2.1 Types of knowledge

To understand the social and spatial patterns of knowledge flows and innovation we need to be sensitive for the type of knowledge involved. In this regard an established distinction is that between codified and tacit knowledge (Polanyi, 1967). Recently, Asheim and Gertler (2005) have criticised this binary classification for a narrow understanding of knowledge and innovation. This led to a conceptualisation of different types of ‘knowledge bases’ that are used in innovation processes. A distinction is made between ‘synthetic’, ‘analytical’ and ‘symbolic’ knowledge bases (Asheim, Boschma and Cooke, 2007; Asheim, Coenen and Vang, 2006). This distinction takes account of the rationale for knowledge creation, the criteria for successful outcomes, the strategies of turning knowledge into innovation and the interplay between the actors involved. The categories entail different mixes of tacit and codified knowledge, qualifications and skills required by organisations, as well as specific innovation challenges and pressures. The typology encompasses the diversity of professional and occupational groups. The paragraphs below identify the main characteristics of the three knowledge bases as identified by the proponents of the conceptualisation[3].

An **analytical knowledge base** refers to activities where scientific knowledge based on formal models and codification is highly important. Biotechnology and nanotechnology are identified as typical examples. Knowledge inputs and outputs are often about developing new knowledge about natural systems by applying scientific laws – ‘know why’. Although the knowledge is often codified, tacit knowledge is not irrelevant since innovation always involves both types of knowledge. University-industry links and networks are relatively important. The activities require specific qualifications. In particular analytical skills, abstraction and theory building are often needed. The core of the workforce often needs some research experience or university training. Knowledge creation in the form of scientific discoveries and generic technological inventions is relatively important and often lead to patenting and licensing activity. Knowledge application is in the form of new products and processes and innovations tend to be relatively radical. An important route of knowledge application is new firms and spin-off companies based on radically new inventions or products.

[3] The following paragraphs draw on Asheim, Boschma and Cooke (2008) and Asheim, Coenen and Vang (2006).

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. Plant engineering and shipbuilding are proposed as industry examples. Products are often one-off or produced in small series. R&D, especially the research element, is generally less important than in the analytical knowledge base. If relevant it often takes the form of applied research, but more often it is in the form of product or process development. University-industry links are sometimes relevant but clearly more in the field of applied research and development. Knowledge is often created in an inductive process of testing, experimentation, computer-based simulation or through practical work. Knowledge output can be partially codified but tacit knowledge is more prevalent than in the analytical knowledge base, in particular due to the fact that knowledge often results from experience gained at the workplace and through learning by doing. There is a relatively high requirement of concrete 'know how' and practical skills often provided by polytechnical schools and on-the-job training. Innovation tends to be an incremental process, dominated by the modification of existing products or processes. Most innovation takes place in existing firms while spin-offs are relatively less frequent.

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. This type of knowledge is considered particularly relevant to 'cultural industries' such as media, advertising, design or fashion. An important part of the innovation in these industries takes the form of the 'creation' of new ideas and images, rather than new physical production processes. In the cultural industries in particular the input is aesthetic rather than cognitive in quality. The knowledge involved is incorporated and transmitted in aesthetic symbols, images, and narratives with strong semiotic knowledge content. This type of knowledge is often narrowly tied to a deep understanding of the habits and norms and 'everyday culture' of specific social groupings. Due to the cultural embeddedness of interpretations this type of knowledge base is characterised by a distinctive tacit component and is often highly context-specific. The acquisition of skills is less tied to formal qualifications and university degrees than to practice in various stages of the creative process. The process of socialisation (rather than formal education) in the trade is not only important with regard to training 'know how', but also for acquiring 'know who', that is knowledge of potential collaborators.

The knowledge base conceptualisation implies that different industries are characterised by different social-spatial conditions and pathways to innovation. In relation to space, the proponents suggest that the different knowledge bases are characterised by different sensitivities to geographical distance for knowledge flow (Asheim, Coenen and Vang, 2006). Industries drawing on the analytical knowledge base rely heavily on codified knowledge that tends to be publicly available. As a result face-to-face is believed to be of less importance in the process of accessing scientific knowledge. At the same time, companies in this industry are believed to cluster near major universities partly to gain access to world leading researchers. Industries drawing on a synthetic knowledge base are more sensitive to geographical distance. Face-to-face communication is of greater importance due to the importance of customised solutions and the partly tacit nature of the know-how involved. Industries drawing on the symbolic knowledge base are believed to be most sensitive to geographical distance in relation to knowledge exchange. 'Know-who' type of knowledge is augmented through large gatherings which require face-to-face contacts. In addition, the craft-production nature of the innovation process and the tacit nature of the know-how call for a high amount of face-to-face communication.

The proponents stress that the threefold distinction outlined above refers to ideal types and that most activities are in practice comprised of more than one knowledge base. Innovation projects often involve actors from different industries with different knowledge base characteristics. This has been convincingly illustrated by the micro-scale studies conducted by Moodysson et al. (2008). Here the focus is the 'mode of knowledge creation' - the

characteristics of the actual knowledge creation activities and knowledge interactions - in specific innovation processes, within one particular industry. This allows for a concrete investigation of how the different modes are integrated in concrete innovation projects. The case study findings show that different modes of knowledge creation are present in different phases of innovation processes, but with different intensity, and different outcomes for the spatiality of the knowledge flows. Even at the activity level it is not possible to characterise activities as either analytical or synthetic. However, in most cases the authors were able to clearly identify a dominant mode of knowledge creation in the different activities. In terms of the space, the findings broadly support the idea that synthetic modes of knowledge creation are relatively more sensitive to proximity effects than analytical modes of knowledge creation but the mix of modes results in "a more fine-grained picture" (Ibid. p. 1053).

1.2.2 Central occupational group and the organisation of knowledge communities

The knowledge flows and innovation processes of different industries are shaped by their dominant occupational groups and the way knowledge communities are organised. In sectors where the dominant occupational groups are highly professionalised and have achieved a high degree of social closure around their formal knowledge base, we might expect a more hierarchical organisation of knowledge flows (see also Lester and Piore, 2006). However, more decentralised relations in an open network incorporating multiple professions, occupations and sources of expertise are likely to generate different types of knowledge flows – whether this takes the form of 'heterarchical logics' within firms (Girard and Stark, 2002) or interpretative work in 'public spaces' such as industrial districts or universities (Lester and Piore, 2006). Given the importance of formal science and medicine in biotechnology and the more commercialised world of commercialised developers and technical professionals, with much weaker social closure, in the digital media sectors, we can expect significant variations.

The form of organisation of knowledge communities is known to vary from sector to sector with important consequences for knowledge flow and innovation processes. In this respect Coenen et al. (2006) have usefully employed the distinction between communities of practice and epistemic communities. Communities of practice (Lave and Wenger, 1991) can be defined as groups of actors (individuals) involved in a specific task and communicating regularly with each other about this specific task. Epistemic communities (Haas, 1992) are groups of individuals who share a specific set of knowledge but who work independently of each other. These networks are less formal and knowledge flow is not dependent on a common task or job.

1.2.3 Organisation of firms and markets

Important differences exist between sectors in terms of the organisation of firms and markets, the size and age profiles of firms, the type of user markets and forms of regulation. Biotechnology is characterised by a combination of very large and very small firms. Although much of the output is used by patients, the main "customers" are high-status medical professionals and healthcare organisations. Product development processes and markets are intensely regulated by national regulatory authorities. In the digital media sector, small and micro-scale enterprises are more prevalent. Popular culture makes up an important segment of the user market. With respect to regulation, there has been a shift away from government regulation and indeed censorship to co-regulation or self-regulation by the media industry. Digital media in Ireland are very loosely regulated - what is often referred to by policy makers as 'light touch regulation'.

All this has important implications for knowledge flow and innovation processes. Oakey's (1995) research in the UK is still helpful here. In a systematic study of the activities of new technology-based firms in the 1980s, he found major differences between the operations and trajectories of biotechnology and software firms (relatively close to our digital media sector).

Biotechnology is a clearly distinct sector. Biotech firms tend to maintain close links with their founders' previous employers, particularly in the area of research. The intense level of regulation significantly increases the length of time and costs involved in innovation which means that biotech firms require very significant amounts of external funding and operate to a much longer time horizon than in the other two sectors. They are more likely to introduce external executives at an early stage and to develop a formal business plan. Overall, their product development lead times are by far the longest, their capital requirements are the greatest and they rely most heavily on formal scientific knowledge.

Software firms are in many respects the opposite of biotech firms. They continue to be based heavily around the founder's expertise and interests and rely much less on formal R&D, internal training and external funding (unless they are pursuing a particularly aggressive growth strategy). They have the fewest links to universities and the most to industrial firms. Their time horizons are shorter and the level of external support they require, although substantial, is much less. The earlier identified move to co- and self-regulation has placed the onus on digital media companies to have sufficient expertise and knowledge of their markets and their regulatory structures in-house or to work collaboratively with media publishers and firms who have this local knowledge. For SMEs the latter is the dominant trend.

Clearly each of these sectors has different requirements in terms of funding, R&D, technological networks and links to universities and other sources of public research. The differences go further than this to shape employee relations and learning cultures. A study of firms in Silicon Valley in the mid-1990s found similar differences among firms in a range of 'high tech' industries – including telecommunications, computer, medical and semiconductor companies (Baron et al. 1996). Computer and semiconductor companies tend to adopt an 'engineering' model of management – where staff are organised into teams and motivated by the opportunity to do interesting work. Medical companies (closest to biotech) are more likely to adopt a 'star' model – focused on attracting the 'best' researchers and providing them with a great deal of autonomy. Sectoral differences extend therefore to the models of learning and management-employee relations that firms tend to use.

Each of these dimensions – knowledge bases, the central occupational group/organisation of communities, and the organisation of the firms and market – will profoundly shape the different sectoral pathways to innovation.

1.3 T11.1 Research design

1.3.1 Introduction to case study research

The study in T11.1 follows a case-study design as defined by Yin (1993; 2003). Yin defines the case study as an empirical inquiry that investigates a phenomenon within its real-life context, especially in situations in which the boundaries between phenomenon and context are not clearly evident, and that uses multiple sources of evidence. What distinguishes Yin's conception of a case study from traditional quantitative research follows from the concern with context. The richness of the context means that the study will have "more variables than data points" (Yin, 1993, p. 3) with important implications for generalisation. Furthermore, the richness means that the study will likely use multiple sources of evidence that can be quantitative or qualitative. This makes statistical analysis difficult or impossible.

Yin's case study design or approach is more than a method of data collection - it covers the logic of design, data collection techniques, and specific approaches to data analysis. Yin's case study approach should not be equated with qualitative research or confused with specific methods of data collection such as ethnography or participant observation. "Some qualitative research follows ethnographic methods and seeks to satisfy two conditions: (a) the use of close-up, detailed observation of the natural world by the investigator and (b) the

attempt to avoid prior commitment to any theoretical model. However [case studies are not] limited to these two conditions. Instead case studies can be based on any mix of quantitative and qualitative evidence. In addition, case studies need not always include direct, detailed observations as a source of evidence" (Yin, 2003, p. 15).

What distinguishes Yin's concept of a case study from ethnography and grounded theory is the idea that case study research can be explanatory and test theory. Along with exploratory and descriptive case studies, he distinguishes explanatory case studies (as one form of causal case studies) oriented to the testing and advancement of theory and thus part of a cumulative body of knowledge rather than isolated empirical enquiries. The traditional idea is that research questions that posit a strong causal relationship between variables suggest some form of experimental research design and the use of statistical tools to make inferences from one's sample to the larger population (Nunam, 1992). Yin on the other hand argues that cause-effect relationships can also be researched with case studies. Exploratory and descriptive can be used to address "what", "where" and "who" questions while the explanatory case study can be used to answer "how" and "why" questions.

According to Yin, causal case study research favours explanatory theories, particularly complex ones. Here the researcher uses existing explanatory theories to determine the causal relationship. The case study is characterised by a strong adherence to the hypothetico-deductive framework. As in traditional quantitative research, theoretical framework and hypotheses/postulations are developed in advance of the data gathering and data analysis process, and the research design involves testing of these hypotheses. However, the explanatory theory in a causal case study involves a different approach to design, generalisation, testing and validity.

As regards the problem statement, the explanatory case study approach is most appropriate for 'how' and 'why' questions, i.e. questions that are looking for an explanation rather than a prediction of a phenomenon (Yin, 1984). Theories lead to the formation of a set of causally linked hypotheses together representing the target research pattern or target hypothesis of the study. The explanatory case study involves a specific approach to testing and generalisation, generally referred to as analytical generalisation (Hamel, 1993, Yin 1993). This can be contrasted to the traditional quantitative approach of statistical generalisation. In a traditional quantitative survey design the individual cases represent a sample of a larger population to which the findings are generalised after statistical testing. This approach is not suitable for a case study. A case study calls for intensive amounts of data about a small number or a single unit of analysis. The number of subjects or data points is so small that it cannot outnumber the variables of interest. In other words, "the degrees of freedom would always be insufficient compared to the number of variables" (Yin, 1993, p.81). Furthermore, many of the required data cannot be readily converted to numerical values. Both characteristics make statistical testing and generalisation to a larger population irrelevant.

Instead, "generalisation of the results of a case study is made to theory, and not to populations" (Yin, 1993, P.79). This means that the researcher identifies a theory that the case study is trying to test, rather than regarding the individual case studies as data points or part of a sample. The theory will provide a predicted pattern of events, which becomes a series of benchmarks, a template, against which empirical results can be compared. In this way theory can be tested with empirical evidence collected from a single-case study. However, multiple case designs are likely to be stronger than single case designs and "trying to use even a two case design is a worthy objective" (Yin, 2003, p. 19). Multiple case designs are based on a replication logic rather than a sampling logic. Replication simply yields greater confidence in the robustness of the theory.

1.3.2 Research questions, target hypothesis and unit of analysis

The remainder of this section details the case study research design that guides the current research project for T11.1. The design includes both descriptive and explanatory elements as reflected in the main research questions:

Q1: What are the main social and spatial structures of knowledge flow and innovation in the Irish biotechnology and digital media sectors in terms of firm interaction, firm networks, associational infrastructure and the organisation of worker networks and technical communities?

Q2: How are these social and spatial structures of knowledge flow and innovation shaped by the type of knowledge base, the central occupational group and the organisation of firms and markets?

In relation to the spatial "how" question, a substantial body of research has been carried out leading to theories regarding the impact of different types of knowledge bases and modes of knowledge creation on the spatial structure of knowledge flow in innovation. These theories, outlined in the previous sections of this Chapter, led to the formation of the following target hypothesis:

> The Irish biotechnology industry and digital media industries are both characterised by innovation projects that involve different modes of knowledge creation, appearing in different intensities, during different phases of the innovation project. In the biotechnology industry the analytical mode of knowledge creation is relatively more dominant while the innovation activities in the digital media industry are characterised by a greater dependence on the synthetic and symbolic knowledge bases. This has implications for the spatial structures of the knowledge flows and innovation. Most activities in the biotechnology industry, drawing more on "know-why" type of knowledge, tend to be relatively less sensitive to geographical proximity. Activities in the digital media industry tend to be more sensitive to geographical proximity. Here face-to-face interaction benefits both the exchange of "know how" and "know who" type of knowledge, both intentional and unintentional.

The unit of analysis is *the successful innovation project*. We 'select on the dependent variable' to show examples of successful innovation and ask what variations exist in pathways to innovation and what explains those pathways. The methodological decision to focus on 'success stories' means that we are focusing on the variety of pathways to 'success' (and the various socio-spatial organisational forms compatible with 'success'), rather than on a comparison of the factors shaping whether firms innovate or not. Innovation projects potentially involve a range of actors, including firms, workers, firm networks, person-to-person networks, technical communities, universities and other institutions.

We leave the structure of innovation production, and of the socio-spatial relations that constitute it, methodologically 'open'. In other words, we attempt to avoid building in to the research design any particular actor or institutional form as the main 'home' of innovation. We do not begin with the presumption that the firm, the network, the technical community, the region or any other such entity is the primary actor in the innovation process. In fact, we seek to design our research such that we can assess how these various entities interact with each other to shape the overall innovation process.

1.3.3 Criteria for case selection

We adopt a multiple-case design involving two subgroups – projects in biotechnology and digital media. Within each sector we conduct a number of case studies serving a literal

replication logic (Yin, 2003). Project selection was based on a review of secondary material and a set of initial interviews with industry experts in the Irish industry (see section 1.4 for an overview of the two sectors). This provided an overview of the two sectors and its main sub-sectors as well as a list of companies. The unit of analysis for the research is innovation *projects* but we had no universe of projects. Instead, we used the list of companies to steer the case-study selection, which was strongly informed by the opinion of the industry experts. The case-study selection was guided by a number of selection criteria:

1) Given the focus the OPAALS research project on SMEs, the selected innovation projects should have a strong involvement of SMEs in Ireland (i.e. a substantial part of the innovation project should be carried out by the Irish SME or research group).
2) Part of the reason for selecting Biotechnology and Digital Media as the focus of our study was that the literature suggests that the two industries could serve as examples of industries dominated by different knowledge bases or modes of knowledge creation. Therefore, one of the criteria was that the project was a "typical" case of such a knowledge base. This means that the project is not "representative" for the entire industry (such a project does not exist in any case).
3) Having said this, in order to increase the policy relevance of the study in the Irish context we wanted to include projects from a sub-sector that is well represented in Ireland.
4) We were hoping to select innovation projects that are in an advanced stage, preferably already on the market.

The selection of innovation projects obviously raises questions as to how we define innovation. We adopted a broad definition: Innovation processes involve the exploration and exploitation of opportunities for new or improved products, processes or services, based either on an advance in technical practice, or a change in market demand, or a combination of the two (Pavitt, 2006).

1.3.4 Data collection

As regards data collection methods, the case studies will take the form of "innovation biographies" - in-depth micro-studies tracing back the history/genealogy of particular innovations. We are concerned to see how the social spatial relations of innovation vary over time throughout the innovation process. We therefore begin with the innovation itself and carry out an innovation biography that explores how the innovation emerged over time. Taken together, the innovation biographies will give us a picture of the particular 'innovation coalitions' that underpin innovation processes and outcomes. This will allow us to 'map' the actors that are involved in the innovation process at different stages, how they interact with each other and how their boundaries shift and change over time. This will therefore allow us to examine how firms, inter-firm networks, technical communities, universities, industry associations, government labs, individual contractors, etc, relate to one another at different stages of the innovation process by creating a 'map' of the relations at different stages. We will also be able to examine the shifting spatialities of the process at different stages by placing the various actors within different spatial scales (local, national, regional, transnational, etc.).

During the first phase of the research projects interviews were conducted with a number of industry specialists. The aim of the interviews was to obtain a first impression of the relevance of the conceptual framework and target theory in the two industries and to guide case-study selection. In the second phase of the research, for each innovation project, interviews will be conducted with staff from relevant companies, universities and other institutions in Ireland and, where relevant, abroad. Interview data will be supplemented and triangulated with information from secondary sources, notably annual reports, journals and Internet sites.

1.4 The biotechnology and digital media industry in Ireland - case study selection

As mentioned in the previous section, the selection of the case studies was guided by a number of theory-driven selection criteria. This process required detailed information about the Irish biotechnology and digital media industries. This information was collected via a review of secondary material and interviews with industry experts. This subsection presents some of the main characteristics of the biotechnology and digital media industries in Ireland that have influenced the case-study selection.

1.4.1 Modern Biotechnology

This study focuses on the modern biotechnology industry. The "modern" refers to the post-genetic engineering era that is after scientists had developed the knowledge techniques and tools to intervene directly at the gene level (Laage-Hellman et al., 2004). The definition of the modern biotechnology and the operationalisation of such a definition are the subject of intense debate and controversy. A diversity of definitions exists. Some studies focus on particular industries while others argue that modern biotechnology should be regarded as a diverse set of knowledge bases and an enabling technology that has affected different industries (Brink, et al., 2004).

The OECD (2006) applies a combination of a single definition and a list based definition. Biotechnology is defined as the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or nonliving materials for the production of knowledge, goods and services'. It has been rightfully pointed out that this would encompass not only most biomedical R&D and commercial activity that involves laboratory animals or humans but also virtually all of agriculture, baking that uses yeasts, and the production of fermented beverages and foods, including beer and yogurt (Millar, H. 2007). In order to narrow the definition to modern biotechnology, the OECD employs a list based definition that includes various techniques and activities: synthesis, manipulation or sequencing of DNA, RNA or protein; cell and tissue culture and engineering; vaccines and immune stimulants; embryo manipulation; fermentation; using plants for cleanup of toxic wastes; gene therapy; bioinformatics, including the construction of databases; and nanobiotechnology.

In terms of output or application, biotechnology tends to be colour-coded into red, white, green and blue biotechnology, although there does not appear to be a full agreement regarding the precise meaning of the colours. Red tends to be linked to medical biotechnology – used in the diagnosis and treatment of diseases. White biotechnology (sometimes referred to as grey biotechnology) focuses on using biological organisms to enhance industrial processes, often with an environmental nuance. Green tends to be linked to agricultural and food production biotechnology. Finally, blue is linked to aquaculture and marine biotechnologies.

Even if we agree over a definition of biotechnology we run into the difficulty of defining a biotechnology firm. When do we call a firm a biotechnology firm? Most firms use various technologies and produce various applications. Some firms produce or sell products that include a biotechnological agent but this agent is developed and manufactured by another company. Biotechnology is an "enabling technology". Many companies are enabled by biotechnology but the percentage to which they are enabled by biotechnology differs from company to company. As a way out, many studies limit the population to core or dedicated biotechnology firms. However we can not assume that all activities and outputs of these firms are related to biotechnology while the biotechnology activities of larger diversified firms can be substantial (Arundel, et al., 2007; Brink et al., 2004).

Partly due to the lack of official statistics and partly due to the ambiguous nature of the definition, it is difficult to determine the size of the Irish biotechnology industry and its sub-sectors. Enterprise Ireland, provides a directory of biotechnology companies on its Biotechnology Ireland website. The directory lists hundreds of companies but includes many

non-biotechnology companies, such as accountants and consultancy firms. The Circa Group Europe conducted one of the first attempts to inventorise the modern biotechnology industry InterTradeIreland (2003). The definition of modern biotechnology employed was "the application of molecular biology, cell and tissue culture or recombinant DNA techniques to organisms, cells or parts thereof in the manufacture of product or a as a component of service provision". Only companies whose staff skills/expertise or manufacturing processes were predominantly based on modern biotechnology were selected and surveyed. The report states that 41 companies in the Republic of Ireland responded to the survey but it is not clear what this means for the overall size of the industry in Ireland. We do learn that in terms of number of companies pharmaceutical-biologics (12) and diagnostics (13) are the main sub-sectors, followed by agri-food (8), pharmaceutical services (6) and bio-environmental (2). 18 of the 41 respondents were foreign owned companies.

More recently the same consultancy group conducted a second survey (Irish Bioindustry Association, 2008). Here they used the above mentioned OECD definition. Only companies involved in R&D were included in the survey. Thirty-eight companies were identified according to this criteria but it is not clear from what sources this universe of firms was constructed. The results show that red biotech is by far the largest sub-sector in Ireland with 74% of the respondent firms classifying themselves as medical and a further 4 percent as medical and agricultural.

As part of the research in T11.1 and to support case-study selection we created a new universe of firms. The initial list was based on the InterTradeIreland report and the Biotechnology Ireland web-site. All companies that matched the OECD definition and that were R&D-active in Ireland were included in this initial list, no matter their size. The list was checked by industry experts, which lead to the removal as well as addition of companies. Based on information provided in previous reports, internet search and information obtained from industry experts, companies were categorised in five sub-groups - bio-pharma, bio-diagnostics, green biotech, white biotech and blue biotech. The bio-pharma and bio-diagnostics sub-sectors were purposefully distinguished because the initial interviews suggested that they are characterised by different knowledge bases and different regulatory regimes (see below). Biotechnology services were distinguished because of the fact that some services companies are providing a more or less routine service and are not actively involved in innovation processes. On the other hand some service companies are actively involved in innovation while in other cases the service provided was based on an initial innovation of the company.

Table 1.1: Research-active biotechnology companies in Ireland

Dominant activity	Indigenous companies	Foreign companies	Total
Bio-pharma	17	16	33
Bio-diagnostics	16	5	21
Green biotech	3	7	10
Biotechnology services	10	-	10
White biotech, blue biotech and unknown	6	-	6
Total	52	28	80

***Source*:** compiled on the basis of information obtained from InterTradeIrleand (2003), Biotechnology Ireland website and interviews with industry experts**.**

The resulting universe of 80 biotechnology firms is presented in Table 1.1. The universe is clearly larger than the lists included in the earlier surveys. The discrepancy is most likely related to the inclusion of all firms, including all start-up and early stage campus companies. The list includes 28 foreign-owned companies. Most of these companies are subsidiaries of large multinationals and have a strong manufacturing focus. The R&D activities tend to be concentrated in process development. The main indigenous sub sectors are bio-pharmaceuticals and bio-diagnostics. The bio-pharma sub-sector is even more dominant than the table suggests, since the majority of the indigenous biotechnology services companies are active in biopharmaceuticals. As regards size the data are incomplete. What we know is that all but two of the indigenous companies are SMEs. It is estimated that the majority of indigenous companies in the list are micro-enterprises, employing less then 10 staff - often start-up companies or campus companies. The majority of the other indigenous companies are small enterprises, employing less than 50 staff.

This list of companies formed the basis for the case-study selection, which was heavily informed by the industry experts. The unit of analysis for the research is innovation *projects* but we had no universe of projects and used the list to steer discussion. The case study selection criteria led the selection of projects in the bio-pharma and (part of) the biotechnology services sub-sectors. Both sub-sectors, like all sectors, are characterised by a strong involvement of SMEs. The initial interviews made clear that most companies in the bio-pharma sub-sector are relatively strongly "biotechnology enabled" while the core competence of a substantial number of bio-diagnostics companies is concentrated in the area of chip design or engineering, rather than biotechnology. The aim to select innovation projects that are at an advanced stage proved more problematic in this sub-sector because most Irish SMEs in this sub-sector are at a very early stage of their development. Depending on the level of co-operation, we may be forced to include cases that are at a relatively early stage in the cycle.

1.4.2 Digital Media

Digital media as a concept emerged in the mid to late 1990s and was used to refer to new media or 'multimedia' artefacts like Internet web sites and computer games. However, as traditional mass media like television, film, music and animation started to move from old analogue platforms to digital platforms, distinguishing between analogue and digital media began to make no sense. All media were becoming digital, even if the original content was created in analogue form.

Definitions of what constitutes the digital media industries generally include a range of media and entertainment industries and some ICT industries. However, the use of the concept varies and it can be applied quite narrowly to include mass, new media and some software activities or broadly to include all media, software and ICT related activities. In the UK, the concept of the 'creative industries' has emerged in policy circles but this concept is very broad and includes traditional media, new media, arts and crafts and software industries more generally.

All forms of digital content could be easily combined or recombined leading to a proliferation of new forms of hybridised content and new distribution platforms like the internet and wireless which means that digital media products and services can be accessed on demand across borders and time zones. Today digital media and the processes of production and consumption which emerged around them in the early part of this century have become 'thoroughly embedded and routinized in the societies where they are widely used' (Lievrouw and Livingstone 2006:3).

In Ireland a review of key institutional actors and policy documents signal that 'digital media', the 'digital content' industry and to a lesser degree informatics remain the dominant

concepts[4]. In the policy body Enterprise Ireland, there is a person responsible for the 'TIME' sector that includes telecoms, Internet, media and edutainment software.

In a 2002 report published by the industrial policy making body Forfás, the concept of the 'digital content' industry was used. The concept was defined broadly to include a range of sub-sectors e.g. entertainment, education, consumer information and business/professional related content and to include companies involved along the value chain, from content design and authoring to packaging, publishing, marketing and distribution. Entertainment included animation, games, digital film, digital TV and music while education included e-learning companies. Included in the other sub-sectors was Internet and wireless publishing and corporate communications. A key difference from the creative industries concept lies in the exclusion of traditional arts and crafts and non-content related software production from the latter.

In 2002, it was estimated that there were a total of 282 significant companies in the digital content sector in Ireland, employing between 4,000 and 4,500 employees. The industry is mainly comprised of indigenous companies, which accounted for 84% of the companies and the most significant sub-sectors by total numbers of companies are in business publishing/web based services, digital television and film and e-learning. Almost 90% of the industry is located in Dublin in the south city centre. A minor cluster exists in Limerick in the e-learning area. A majority of the companies are focused on the Irish and UK markets. The report stated that the industry 'is at a relatively early stage of development, and largely comprises of micro-enterprises fragmented across a range of entertainment, education, consumer and business information sectors. The most notable exception to this is e-learning, Ireland's most successful Digital Content sector (Forfás 2002:118).

Growth projections in these reports were optimistic with an annual average growth rate of 29% in the sector expected between 2001 and 2006. In face-to-face interviews, Irish digital media companies were less optimistic and anticipated slower growth in employment. Significantly, in a study of 23 digital media companies across the different sub-sectors almost 80% of employees was full-time with almost 15% on permanent contracts and the rest on temporary contracts. Only one of these companies had a formal R&D department.

When one examines employment by occupation within a sample of these companies the mix of occupations and skills becomes apparent. The most significant occupations included authoring and design as well as sales and marketing roles while programming jobs while important, constituted a much smaller percentage. Interviews with 23 media companies (20 Irish firms and 3 UK firms) across a range of sectors in 2002 found that:

- Media content authoring and design occupations accounted for 34% of the total jobs in these firms (292 jobs out of a total of 866).
- Management, sales and marketing occupations accounted for 20% of the total employment.
- Software development, IT and system support accounted for 15% of the total jobs.
- Quality control and testing roles accounted for 19% of the total.[5]

The report concluded that while a combination of technical and design skills are present in Irish digital media companies, many lack management and business expertise and face

4 Forfás, (2002) *A Strategy for the Digital Content Industry in Ireland*, Forfás: Dublin and The Digital Hub (2007). *Development Plan. International Digital Enterprise Area, Dublin*. Dublin: The Digital Hub and interviews with policy makers 2008.

5 McNaboe, J. *Skills Requirements of the Digital Content Industry in Ireland: Phase 1*, Dublin: FAS, STeM, Dublin City University and the Expert Group on Future Skills Needs, 2005, http://www.skillsireland.ie/press/reports/pdf/egfsn0502_Digital_Content_Industry_Skills%20Report.pdf.

significant barriers networking internationally, in the absence of a strong local market (McNaboe 2005:21-22). Unfortunately, more recent figures or studies are not available for this sector in Ireland.

Interviews with policy makers in the digital media area in 2008 indicated that the most significant sub-sectors in Ireland in terms of employment and turnover were e-learning and telecoms, although the greatest numbers of companies were in media and entertainment. Typically, the Irish companies had few links to universities but were focused on product or service creation and international markets. Key digital media multinationals located in Ireland include Google, Microsoft, Vivendi, Activision, ebay, amazon and AOL. These companies are serving the European or global markets and are focused on localisation, data management and distribution. There are a number of publicly funded sectoral networks which are attempting to encourage greater knowledge flow between indigenous and multinational companies and universities including ELITE - a CEO forum in e-learning, IMS-ARCS which focuses on instant messaging, a digital media forum and a mobile TV pilot network.

A significant policy initiative since the 2002 report has been an attempt to develop a digital media cluster in south Dublin known as the 'Digital Hub', which was launched in 2002. By the end of 2005 this cluster had 50 companies employing approximately 400 people (The Digital Hub, 2007:8). This cluster aimed to have 100 companies and 900 employees by 2008 (the Digital Hub, 2007:12). This cluster included companies in the games, learning, wireless and entertainment sectors and again at all stages of the value chain[6]. An attempt to develop a European offshoot of the MIT Media Lab in this cluster failed, both financially and in terms of stimulating local innovation, and is currently being replaced by a National Digital Media Research Centre involving Irish universities (Kerr, 2007). Interviews with experts in the Digital Hub have indicated that ad hoc collaboration is starting to emerge in this cluster and an internally commissioned research report on companies in the hub is due to be launched shortly.

Given that the Irish digital media industry has such a small home market it must link internationally to both produce and distribute its products and services. A government commissioned report on the international digital media industry noted that the industry was worth $965 billion in 2004 and would grow by at least 50% by 2009. The key driver identified was technology, from advances in mobile and console technology to the development of Internet and broadband. The report anticipated increasing project sizes and costs in games, the commoditisation of basic skills and tools in areas of animation which would be increasingly outsourced to Asia-Pacific territories and changes in user behaviour and demands as key trends (Forfás, 2006). The report also noted that access to skills, rather than access to education and research, was a key influence on location. Additional factors included lifestyle, cost base and the location of firms target market (ibid, 2006:6).

[6] see http://www.thedigitalhub.com/enterprise_research/company_directory.php for a list of companies

Chapter 2

The role of institutions and IPR schemes in supporting intentional and unintentional knowledge sharing: objectives, methods and theoretical orientation[7]

This Chapter presents a literature review of commentary on the main issues arising from the ways sought to protect and diffuse knowledge with economic value. It includes an ontology of useful knowledge (Machlup, 1958 and 1980; extended by Mokyr, 1990 and 2001 – economist, historian of the Industrial Revolution and philosophical theorist on knowledge). It examines the principles and practice of its protected, restricted and open use. This commentary is part of the research agenda pursued by CAM within T11.2.

2.1 Objectives of the Study

1. To review, critique and evaluate candidate methods of valuing innovations with commercial utility
2. In the light of Objective 1, to compare, across two regions, ways in which a multiplicity of stakeholders currently value innovations, and ways in which they wish to value them in future
3. To disseminate the concept of a Digital Ecosystem within the regions studied, which collectively research and develop in the fields of computer-technology, biotechnology and the eco-technologies
4. To return feedback from the regions studied to the architects of Digital Ecosystems and the OKS, which will assist in the development of specifications.

2.2 How to Value Utility Flowing From New Knowledge: a global approach to innovation protection systems

> *"Since I was Queen yet did I never put my Pen to any Grant but upon pretext and semblance made Me, that it was for the good … of my Subjects generally, though a private profit to some of my ancient Servants who had deserved well: But that my Grants shall be made Grievances to my People, and Oppressions, to be privileged under colour of Our Patents, Our Princely Dignity shall not suffer it".*
>
> *Elizabeth 1 The Golden Speech 1601.*

Invention is at bottom an economic phenomenon. Its exploitation can determine the success of an industry, which in turn translates into a national benefit. Thus, to motivate and foster invention is a national economic mission. I review past popular incentives – prizes, bonuses, and property rights of varying strength.

Previous work to be incorporated in the final literature review will be that of Machlup, Ladas and others. Fritz Machlup was an economist prominent in the 1930s to 1980s. He studied under Hayek in Vienna in the 1920s. Hayek's work will also be cited. Machlup wrote extensively with Edith Penrose and produced the definitive historical and economic review of global patent systems of its time (Machlup, 1958). He introduced *national accounting* to measure the economic value of technological inventions and the knowledge economy, by contrast with the traditional economists' tool of *growth accounting*.

[7] Jo Stanley (CAM)

Commentary will also include the work of legal and economic scholars who recommend methods to value innovation for future adoption. For example, liability rules are explored by Paul Heald, a legal scholar interested in the transaction cost exacted by the patent system. Pamela Samuelson, a US copyright scholar, who together with Jerome Reichman has produced a model for *sui generis*, short duration protection of intellectual property in software that is disassociated from the patent and copyright paradigms (Samuelson et. al., 1994). Reichman, a student of patent history, describes cycles of over- and under-protection of inventions, and addresses, in the Manifiesto and elsewhere, ways to avoid those scenarios.

The knowledge-based industries have always had trouble with traditional IPRs (Stanley, 2003 and 2004) and many alternative means of protection have been mooted. For example, Jerry Reichman has long regarded computer programs as 'intermediate technologies' that fall between the patent and copyright paradigms in the sense that their behaviour deviates from the standard behavioural assumptions that underlie the classical forms of legal protection for either industrial or artistic property, described *sui generis* alternative proposals of protection for software innovation.

Samuelson has long advocated dropping IPRs for computer code, notably for operating systems and object code.

Susan Scotchmer (1991, 1995) and Scott Kieff (2003, 2005) – the latter following Ronald Coase (1937) – explore ways in which property rights might be tuned to moderate transaction costs. Scotchmer, an economist, theorises on how protection of current inventions impoverishes future ones.

The slective use of IPRs is discussed by Bruce Perens, co-funder of the Open Source movement. Perens has explicated a hybrid model, keeping 'platform programs' open, whilst protecting company-specific software by IPRs (Perens, 1999). The patent system has for decades been able to block developments where large multiples of rights are needed to initiate complex projects (Machlup, 1958). For modern examples, DNA on a chip, or eco-building creation (Heller and Eisenberg, 1998).

Abandonment of protection (partial or total) is mooted by Benkler and others and supported in some measure by Jean Tirole and Joshua Lerner (2000) -economic support- and Perens (technical community support).

Dan Hunter has frequently warned on the inadvisability of using the 'information highway', and other territorial metaphors in relation to issues of cyber-space, since it invites extension of the cyber metaphor into (concrete) property law. False metaphor will be broadly addressed as a vein of discussion running through the final review for T11.2.

Throughout the literature of this subject runs a strong vein of scholarly criticism of corporations. We discuss state incorporation law, reviewing the work of Daniel Greenwood, legal scholar and antagonist of the Corporation. Greenwood has referred to the corporation as a 'monomaniac'. We also examine corporate policy, strategy and tactics, referencing views expressed by Will Hutton, student of UK political economy and Joel Bakan, a US legal scholar (Bakan, 2004) We explore the extent and impact of infiltration of academic enclaves by corporate concerns in the United Statees, as chronicle by Jennifer Washburn (Washburn, 2005). We ask, are partents concentrated within corporations? If so, is this an accelerating trend? If shown to be the case, would that be deleterious to society?

As far as corporation history is concerned, we are now in the epoch of multinationals. The wellsprings of corporate form are traceable to Roman law (Reuvan Avi.Yonah, 2005). By the end of the middle ages 'the corporation' had legal personality, could sue and be sued, could even bear criminar responsibility, had unlimited life, and was well entrenched in both civil and common law.

By the end of the eighteenth century and on into the 19th, US and UK corporations moved from non-profit status to being for-profit business concerns. The next major development,

which occurred towards the end of the 19th century and in the early 20th century, was the public trading of corporate shares. The multinational corporation developed after WW11.

These huge firms transcend national boundaries, viewing governments as partners rather than the providers of an overarching framework in which to operate. It therefore becomes clear that any policy approach to the deployment of useful knowledge must fit within a global context since that is the reach of modern trade, exchange of labour, partnerships and international human rights considerations. Recent history has taught us that we have need to be watchful where international agreements promoting first world inventors' rights have health and economy-critical effects on developing world populations. Peter Drahos (Drahos, 2002), one of the most eminent philosophers of Intellectual Property has tracked the appearance of chief executives from the Pfizer Corporation on influential committees that have been instrumental in writing the TRIPS agreement (WTO GATT, Uruguay Round) leading to the suppression of generic drug production for developing world countries.

Finally, the focus is drawn to the internal workings of patent system, using the US system as exemplar, and drawing comparative reference to the European equivalent (Machlup supra, Giles Rich and Pat Federico). The last two of these commentors were dominant figures in the 1950s and -60s in the US Courts and Patent and Trademark Office (the PTO) respectively.

Patent Office practice is examined, and asked how far a patent owner may rely on his patent, does the system deliver the sufficiency of validation it promises; are patents worth their face value? Are they worth defending against infringement? In defending a right in creative product should litigation (all-or-nothing approach) or Coasean negotiation be the first port of call.

Gregory Aharonian, proprietor of the *Internet Patent News*, and informant on the state of health of the US PTO, believes the PTO to be under questionable administration and depleting resourcing – on the point of breaking, in fact. He posits that over 80% of US software patents are invalid. Aharonian's firm *BusPatents* searches prior art for inventors wishing to know whether their technology has already been worked, or whether large companies threatening their market entry hold portfolios of patents of questionable validity.

How the worth of patents is currently evaluated will be examined briefly (Heald *et al,* 2005), and what a portfolio of patents is *actually used for* by the firms. Ought small firms to persevere in their aspirations to gain IPRs or is the way forward progressively to infiltrate proprietary models with community ones? If so, which level or type of innovation is suited to which type of protection or liberation?

This review places strong emphasis on the economic history of the patent system (Machlup, 1958; Mokyr, 1990 and 2001). The work of Arnold Plant, an insightful UK economist, is referenced alongshide that of Ronald Coase (1937). Attempts are made to identify *switch points* in the evolution of the system, which signal fruitful developments, political sea-changes (such as the globalisation of trade) with ramifications into policy on economically valuable creativity - and importantly, wrong turnings.

In the final analysis, have patents been shown to stimulate innovative progress?

The report will present a network model for the *nodal governance* of the modern patent system (Drahos, Braithwaite and Wood) and an open license model for release to the third world of currently restricted, health-critical products (Kapczynski, Benkler *et al,* 2005*)*. In the latter part of the report, attempts will be made to create a nexus between the Drahos nodal governance model and an autopoiesis-influenced network model having global implications, put forward by Neves (Neves, 2001). Neves is a Brazilian legal scholar and autopoiesis aficionado. In expounding his model, he explains how the autopoiesis model cannot hold for a legal system where there is no democracy in its host nation, such that system 'perturbations' in fact amount to control from outside, and the model breaks.

2.3 Field work scheme for an inquiry into how IPRS are being used in the Peterborough environmental industries and the Greater Cambridge knowledge-based cluster

The purpose of this inquiry is to determine how far intellectual property rights are used, desired and catered for in the environmental industries of the Peterborough, and the knowledge-based cluster of Greater Cambridge, and their degree of importance in attracting investment. In addition, the inquiry hopes to locate the extent to which the Digital Ecosystem, most notably its service layer, could be deployed within these commercial and research communities.

The plan is to interview the main players in the industrial groupings of the two districts: the investors, the Innovation Centre leaders (government agencies and University Science and Business Parks, the innovative firms, and their support community (for example, the local law firms and patent attorneys).

In Peterborough, the UK National Centre for Economic and Environmental Development (UKCEED) was recently established its new home, the Eco-Innovation Centre, in the heart of Peterborough's old town. Its child organisation, The Centre for Sustainable Engineering, is set up in the same building. Opportunity Peterborough is mid-wifeing an eco-housing plan (designed last year and projected to begin building in the spring of 2009). Other partners in the project are the East of England Development Agency (EEDA) and the Peterborough City Council. The environmental industries of Peterborough include water management and water/waste water treatment, waste management, energy management and emissions control, renewable energy technologies, air pollution control and environmental monitoring.

In Cambridge fifteen Science and Business Parks have been identified, notably the St John's Innovation Centre - Cambridge, under the leadership of Walter Herriot, and the first comer, Trinity College Science Park in north-west Cambridge.

The Cambridge partner's role is also perceived to include a duty to disseminate knowledge concerning the Digital Ecosystems. This is to be done in collaboration with the OPAALS Dissemination Unit, the Surrey SOA service architecture developers, and the Waterford team working on trust and identity models for DEs. This integrated Task is seen as iterative, working across time with the regional industrial and research communities in order to supplement their knowledge of corporate platform provision with information concerning the concepts and benefits of a true community model for service delivery as exemplified by the DE.

2.3.1 Background to the Cambridge Cluster

Cambridge University is traditionally known for its 'hard science' profile. Recently, however, several commentators have suggested that Cambridge is failing to embrace new soft innovation (see the last two reports from Library House i.e., *Looking Inwards, Reaching Outwards: The Cambridge Cluster Report*, 2007).

The Cambridge High Tech Cluster, mainly populated by University spin-out firms (Segal, Quince, 1985 and 2000) is widely recognised as one of the most important in Europe. Its profile shows particular strengths in Health Care & Life Sciences, Information Technology and Communications.

The maturity of the cluster is illustrated by supporting structures such as Library House. This data and research company provides commercial intelligence to the cluster. Its statistical surveys provide position information and pinpoint commercial opportunities for the city's innovation industries. The web site, publications and news provided by the *Cambridge Technopole* aims at the same goal. The Technopole, in respect of Cambridge is defined as 'a geographic area of intense high-technology innovation activity with the City of Cambridge at

its heart and having the sub-regional Greater Cambridge (about 25 miles radius) as its hinterland'.

In eighteen months a new Innovation Centre will be opened in West Cambridge, well-endowed (to the tune of £8M) by the Hauser-Raspe Foundation. Hermann Hauser founded Acorn Computers in Cambridge in 1978, and now heads the Amadeus group of venture capitalists.

Preliminary interviews suggest that Cluster leaders will investigate versions of the concept of Open Innovation (Chesbrough, 2003, 2006) as a means to revive the current plateau in Cambridge Cluster's growth and investment profile.

A recent comparative account by Rob Koepp (Koepp, 2002) compares the Silicon Valley cluster to that of Cambridge. Both have top research Universities associated with them, though in Koepp's view, Cambridge is the more prestigious and intensively scientific academic community. It ranks fourth in terms of total disclosed European institutional investment (Library House report 2006). Cambridge University began to spin out companies in the early 1960s, though some of the firms servicing the University, such as Cambridge Scientific Instruments, and Pye were in existence much earlier. The history of these important companies is intertwined with Cambridge's academic progress.

The Cambridge Scientific Instrument Company was founded in 1881 by Horatio Darwin. Its partnership deed gave the objectives of the business as `the improvement of scientific instruments'. It developed electron microscopes during the 1960s, and merged with Leica in 1990. Pyes was set up in 1939, and was variously known as Pye Radio Works Ltd, Pye Ltd, Pye Telecommunications, Philips Radio Communications Systems (PRCS) and Philips Telecom-PMR and Simoco International Ltd.

Silicon Valley contains commercial production as well as research laboratories and has far greater commercial heft than Cambridge. The comparison led to a proposal to aggregate Cambridge with London and Oxford to create the so-called 'Golden Triangle'. The triangle would have Oxford and Cambridge Universities as two apices and a group of top performing London University colleges as the third. A Library House report says this:

> While Cambridge *alone* cannot compare with the dimensions of Silicon Valley's industrial cluster, the *combination of the populations of Cambridge, Oxford, Reading and London* dwarfs this figure. Geographically the four UK cities are also probably closer to one another than those in Silicon Valley.

Interviews with cluster leaders in Cambridge indicate that there are logistical reasons why this scheme has little credibility, for example, the highways structure in no way facilitates communications as is the case in Silicon Valley.

The Californian cluster has sprawled into intensive development. Environmental damage, some health problems and poor working conditions for part of the immigrant work force are documented (Naguib Pellow and Sun-Hee Park, 2002).

Cambridge, on the other hand, remains a smallish provincial town with industrial production related to the research activity situated elsewhere. For example, Gerard Fairtlough, founder of Celltech, one of the early UK biotech companies, positioned a major laboratory at Slough, some considerable distance from Cambridge, where more capacity was available. Cambridge planning history is rich with plan rejections for commercial research site expansions. This constrained status is mainly due to local government policies as to how the area should develop (see for example Mott, 1969).

To this day the road structure around Cambridge remains inadequate. The notorious A14, a dual carriageway bottleneck between Huntingdon and Cambridge forks just outside the town to the coastal freight ports and London on the one hand and into Cambridge on the other. There are arguably better train services to and from neighbouring Huntingdon, linking to London, and the North and Midlands. A steep rise in Cambridge house prices over the last

decade now effectively bars ownership for many of the academics working in the University and the spin-outs. Library House report indicates that broadband delivery could also be upgraded.

Whereas Silicon Valley firms attracted venture capital, took patents and commercialised from early days, Cambridge has a collective memory of benevolent, unbusiness-like and idealistic spin-outs, many of which dwindled through poor and ambivalent management and subsequent government micro-management. Also deep in the collective memory of the city's academic community is the fact that the structure and significance of DNA were first elucidated in Cambridge, only for that University to stand by while the profits of commercial development were harvested elsewhere. This record, coupled to the current less-than perfect investment profile may concentrate Cambridge cluster minds on issues of Intellectual Capital in innovation.

The Cambridge Cluster has a core of around 850 high-tech companies (joint report by Cambridge Investment Research Ltd and The Greater Cambridge Partnership, Oct 2006). This is 'Tier 1', (under the CIR/GCP nomenclature). Consultancies and support firms comprise Tier 2. These firms have technology expertise and may hold IPRs, but their main role is to support tier 1. Tier 3 comprises purely support firms doing no basic research. This last tier contains the patent attorneys and marketing companies. An estimated 410 such companies have been assigned to tier 3. This implies that the first two tiers find a role for IPRs, or tier 3 firms would not flourish as they do.

2.3.2 Background to the Peterborough Industries

Peterborough is an East of England fenland town that now claims to have the largest aggregation of environmental industries in the UK. These industries are based on the DEFRA definition of what an environmental industry is (there are 8 categories). Thus far, the local industries have not been arranged in lists into a tiered structure as is the case in Cambridge. This makes it harder to determine the exact status and numbers of companies. Opportunity Peterborough has called for this to be done.

UKCEED identified the cluster in 2000, and mapped the industries in 2001, listing over 250 organisations, which had generated 4,500 jobs and turned over £340M. The mapping was repeated in January 2007 when over 290 sector organisations were identified, providing more than 5,000 jobs (turnover not recorded). Note that around 40% of the total business complement of industries in Peterborough is reported to be engaged in research and development (UKCEED Report, 2005).

Some of these industries have developed locally and are now middle-sized, others are branches of international and major national companies. The industries include water management and water/waste water treatment, waste management, energy management and emissions control, renewable energy technologies, air pollution control and environmental monitoring.

The cluster is believed to have attracted government attention, and informed observers believe that the proposed Cambridgeshire flagship Eco-Town (Northstowe) could provide a shop-window for the activities of the Peterborough Environmental Cluster. HM Treasury estimates that the UK spends £800m p.a. on environmental research, (Brown, 2006), which would include subjects outside the industry (for example, flood defence, nature conservation), but exclude some areas within the industry (many of the technical areas contributing to energy management or instrumentation).

In preliminary interviews, Peterborough companies report finding the acquisition of patent protection, put at its lowest, 'cumbersome and long-winded', and at its worst, not worth the risk of engagement in terms of both time and money. It may cost upwards of £30,000 to patent across Europe, and six times that to defend the patent in litigation.

The proposed pattern of development at Peterborough is that the Eco-Centre should support the development of 2,500 environmental technology companies across the region through a virtual enterprise hub network, which will operate from the centre. The hub is there to stimulate growth and encourage the transfer of knowledge between companies working in the environmental sector. Phase one of the new innovation centre and enterprise hub will run for about three years. Phase two, will see the centre and hub expand to provide further facilities and services for the sector (Press release - Centre for Sustainable Engineering, 2008). This proposed development is a possible opportunity for support from a Digital Ecosystem platform.

2.4 The Choice of Grounded Theory Method for Qualitative Analysis

Grounded Theory Method (GTM) is reported to have 2622 of a total 4134 received citations in the Social Science Citation Index (64%) for all types of methods (Sage Handbook, 2007). The remainder are shared amongst eleven other methods. The method has been used in fields relevant to the Cambridge contribution to the OPAALS project, for example, to explore the feasibility of Open Innovation introduction into firms. West and Gallagher investigated the likelihood that Open Innovation can provide firms with a greater return on their innovative activities and hence impact their holding of intellectual property (West and Gallagher, Chapter 5, *Open Innovation,* 2006).

There are also touch points between GTM and other constituents of the OPAALS research project (Gibson, Gregory, Robinson, 2005; Gibson, 2000; Dick, 2008; and personal communication with Bob Dick, on file with the author; Stanley, Jeffrey and Flowers, 2007).

Grounded Theory is probably best understood in its historical context**.** Glaser and Strauss (Glaser and Strauss, 1967) developed the method as a reaction against what they perceived as extreme positivism, which permeated most social research at the time. The method takes from the logic of Charles Peirce treatment of abduction, consider also the claims that Reichenbach and Popper separated the logic of *discovery* from the logic of *justification*, and allowed only the latter into 'Science'.

In encountering Grounded Theory concepts we immediately come upon the problem of the *forking of the method*. This has led to the current co-existence of at least 3 or 4 flavours of the methodology: (1) Glaser and Strauss' seminal GTM, (Glaser and Strauss, 1967); (2) Glaser's developments and current version of GTM (Glaser, 1978, 1992, 1998, and 2004); (3) Strauss and Corbin's version (Strauss and Corbin, 1988); (4) Charmaz' constructivist approach (Bryant and Charmaz, 2006).

It is therefore prudent to explore the thinking behind the flavours of the bifurcated method before embarking on any choice or application of the method (the *Handbook* provides a rich branching of the core method into extensions, and deeper epistemological debate).

GTM is taken to have these valuable properties for the T11.2's inquiry:

- Holds no initial grand theory to be verified.
- Since it is not a method that verifies a theory, data is not 'forced' to fit a theory, instead a theory *emerges* from the data, *always provided* that the requirement for an understanding of theoretical sensitivity is appreciated, and the ability to abstract is present when the method is applied (for a defence of proper practice of GTM see Suddaby, 2006).

  Glaser's 'defence' of emergence versus forcing (Glaser, 2002) and in his critique of Lincoln and Guba's Naturalist Inquiry (Glaser, 1985) must inform the application of the method. But compare that with Anthony Bryant's attack on Glaser's faith that a theory will 'emerge' (Bryant, 2003).
- Constant comparison, incident-to-incident and incident-to-theory enables simultaneous collection and analysis of data, with swifter progress as a consequence.

- "Theoretical sampling," in which decisions about where *next* to collect data are determined by the theory that is being constructed. This signposting characteristic of GTM can provide robustness and parsimony in selection of candidate sources.
- Glaser's precept that 'everything is data' is particularly suited to a multi-disciplinary project such as OPAALS.
- The output of the method will be theories or hypotheses to be tested. This is appropriate to this early study of the role of intellectual property rights in the Cambridge digital and bio-medical cluster, and the configuration of environmental industries (possibly a cluster) at Peterborough. The latter claim would need to be verified by the Porter test.

2.5 Conclusion

Entrepreneurship in Cambridge is fostered by layers of University-related support, beginning with seed funding for student enterprise through the dedicated start-up investors to the venture capitalists for mid-career company expansion, forward to specialists in the LSE listing procedure. Avalar, one of the few start-up specialists remaining in the Cambridge investor cluster reports that start-up investments (most notably in Biotechnology) have not made money for the past eight years, the Cambridge Phenomenon's heyday being timed as from 1985 to 1999.

The Peterborough picture is quite different, it being probably the largest town in the UK without a University. Its social profile is that of a severely deprived area. Health, Police, Learning and Skills Council and other reports, and a synthesis of statistics in the PACEC report *infra* all bear this out. The commercial landscape is a jagged mixture of home-grown independent SMEs together with other natives, subsequently acquired by huge US corporations, most notably in the advanced engineering sector.

Across these diverse cities lies the contrast between the prolific patent holdings in all Cambridgeshire, which grew sharply from 2002 (The Peterborough Sub-Regional Economic Strategy 2008-2031, PACEC Report, June 2008). The slump in Peterborough patents begins from the same date. Although the Peterborough of [2005] housed around one fifth of the VAT registered companies in Cambridgeshire, it obtained only 6 patents as compared to the whole county grants of 190, making its patent rate (patents per thousand companies) – which was 0.57 in 1995 and then double the county rate – a poor 0.13 in 2005, as compared to the whole county rate of 0.71, (PACEC analysis of Patent Office figures). Yet even the high tech cluster communities of Cambridge express concern as what their next IP valuing strategies will be.

This mosaic of factors presents the following opportunity for OPAALS, the provision of a prototype DE implementation that might:

- Address the social issue of the isolated and economically inactive members of Peterborough's society
- Address the needs of Peterborough's existing SMEs and start-ups, and the possibility of Open Innovation adoption across the major engineering and other sector giants at Peterborough, with SME inclusion
- Bring the concept of a Virtual University to the town as an extension and specialisation of the OPAALS Network of Excellence.

There is also the possibility to conduct a parallel study of present and future means of valuing innovation, balancing benefits to both creators and society at large and exploring the effects of old and new strategies across the two cities.

Chapter 3

The knowledge creation process: structures of communication and collaboration among Actors in Indian agriculture: objectives, methods and theoretical orientation[8]

Studies reveal that communication networks and organisational forms of the twenty first century are undergoing rapid and dramatic changes. Innovative approaches have emerged to form digital-knowledge-organisation, which is an effective platform to facilitate mutually reciprocative and open-ended process of knowledge creation and exchange. Research in T11.3 will focus on the study of the process of collective learning and the creation and sharing of knowledge among actors who interact with each other on the basis of commonalities of interest using a digital ecosystem-like ICT platform. To create novel and useful knowledge nuggets often requires divergent viewpoints and even some degrees of conflict between agents. Thus, for knowledge flows and sharing there is a need of a structure that is neither too organic and informal nor too rigid and hierarchical. By developing a structure that connects localised knowledge clusters with each other we can build on knowledge flows and knowledge spillovers between them. This would enable us to overcome the shortcomings in local knowledge by viewing each local (spatial) cluster as a node in a global network by creating a multi-scalar geography – a combination of horizontal and vertical networks. Local interaction coupled with interaction through networks with other nodes would create a dynamic process of knowledge creation.

The study in T11.3 will elaborate upon this paradigm, using theoretical insights and experiences from Phase I of OPAALS to study an ongoing process of network building. Several key institutions (knowledge nodes) in the domain of agriculture have come together under the umbrella of a knowledge management project - the National Agricultural Innovation Program (NAIP) - to create cultural and institutional proximity among these nodes to support both intentional and unintentional sharing of knowledge.

3.1 NAIP-Knowledge Management System

One of the many objectives of the OPAALS project is to collect empirical evidence from the Indian agricultural domain on community networks and the knowledge co-creation process. In this context we look into the NAIP-Knowledge Management system as participant observers. The member institutions under NAIP are functionally clustered into three main groups with their different roles and responsibilities. The first group consisting of IITK, IITB, IIITM-Kerala and NAARM-Hyderabad, is supposed to play the role of ICT resource institutions. Private sector partners including NGOs in applied IT development will be brought on as consultants/contractual services providers for short term requirements of the partners. The second group of institutions consisting of GB Pant University of Agriculture and Technology and University of Agricultural Sciences-Dharwad, supposed to provide agriculture information and learning resources. The third group consisting of ICRISAT-Patancheru and NAARM-Hyderabad is supposed to provide the facilitation support for agriculture research scientists and educators and the ICT4D actors. NAIP project is expected to result in significant enhancement of capacity among the agricultural experts at various levels in the refinement and management of new knowledge flows and platforms. The adopted process is to blend the multidisciplinary technological and research oriented knowledge organisations in order to connect the users through a series of software interfaces to enable multi-mode delivery. The NAIP's approach is to create a knowledge organisation and facilitate knowledge management that allows the development of highly integrated

[8] Runa Sarkar, Amritesh, Kasturi Sadhu Ghosh (IITK)

approaches between agriculture research and education sector with established extension processes such as Krishi Vigyan Kendra (KVK) as well as with emerging actors in private sector extension and with organisations prompting rural information access centres. The network created by the knowledge nodes is supposed to develop new and revived linkages between research and education sectors with agriculture extension, through the use of ICT mediation and contemporary practices of knowledge management. The emphasis is to provide information support services to the extension personnel and farmers in a seamless and tailor-maid fashion. Firstly, this program intends to build a comprehensive knowledge base that can combine a host of generic and location-specific information emerging from various National Agriculture Research Systems (NARS) and international partners, and later organise them using an interface patterned after the Wikipedia. This will also make use of a forum (online or offline) to receive queries and support discussions, thus enabling dynamic information to be captured in the main content organisation. The same system is also supposed to enable the capture and use of dynamic data on weather or commodity prices or map/imagery information for rapid processing in support of decision-making at local or institutional level.

The project group at IITK will be closely following and analysing developments among the participants, with respect to the creation, sharing, editing, enhancing and semantically combining, of knowledge. As knowledge communities of practice from geographically and culturally disparate research and academic institutes having common interests in agriculture come together using a digital ecosystem-based IT infrastructure, it is hoped that several factors underpinning knowledge co-creation can be explored. To foster social capital (elaborated in sections 3.3.2 and 3.3.3) there is a need for easily grasped depictions of social capital patterns in current social networks and knowledge of which alternative patterns would best foster knowledge creation and sharing. By actively engaging in the e-community of practice, and using our leanings and the past experiences, the research team at IITK intends to create a functional e-community of practice among experts and practitioners in the agricultural domain to promote a process of autopoietic social learning.

3.2 T11.3's goals and challenges

The projected goals of T11.3's research that are expected to be met within the stipulated timeframe are:

1. Create a typology of network structures among 'knowledge-actors' in the Indian rural domain.
2. By using insights from literature, identify and attempt to develop a suitable 'soft' architecture for creating a DE in the Indian rural domain.
3. Evaluate relative participation rates for commissioned content (hierarchical networks) vs. contributed content (horizontal networks).
4. Compare content quality and appropriateness between commissioned and contributed content.
5. Determine the role of localised cluster networks (intranet), whether geographic or interdisciplinary, in strengthening networks between clusters (internet).

The area of knowledge co-creation, being an unexplored and a comparatively under-researched area of study, there are many challenges which need to be addressed using the tools of contemporary development of communication besides those of economics and sociology. Following are few major challenges in this research:

- Evolve a multi-theoretical perspective as a way to compare and integrate diverse communication theories to increase the explanatory power of the research effort.
- Identify and understand the nature of mutuality, reciprocity and agility of the existing social capital patterns with a view to integrate it with ICT.

- Locate the potential physical spaces which can be further used as knowledge nodes in order to facilitate effective synthesis and transfer of knowledge in a digital mode.
- Developing theories to precisely organise the knowledge management system in an appropriate hierarchy having clear accountability and responsibilities for each knowledge node.
- Choose measurement indicators for content quality appropriateness in order to categorise them into 'need priority' based different knowledge compartments.
- Measurement of compatibility of the available ICT infrastructure with respect to the existing social capital patterns.
- To develop viable network integration theories for a back-end digital system.

3.3 Literature review and synthesis

3.3.1 Evolution of social systems as 'legal personalities'

Over the course of the twentieth century the world is moving towards greater democratic and humanistic ideals with their expanded domains over society and the economy. Joint ventures with commonality of stakeholders' interests have structured big Corporations as dominant institutions and a new form of legal 'person' of the new era. A key premise is that the corporation is an institution – a unique structure and set of imperatives that direct the actions of people within it (Bakan, 2004). There is a need to create a similar kind of legal personality composed of common social interests, which prompts to revive values and practices of democracy, social justice, equitability and compassion, having socially favorable externalities. The existing infrastructure of social institutions can be knitted together with the help of ICT and designed to behave in a desired and systematic way based on a planned virtual knowledge based system. The sustainability measures of such knowledge system can be accessed from the nature of network and interactivity among their member nodes, which is elaborated and described in the context of existing social relationships.

3.3.2 Social relationships

Any social system has many historical beliefs, ideas and cultural practices that define the nature of the existing relationships and form the 'Social Capital'. Social Capital can be further elaborated as the pattern of historically evolved set of relationships in the form of interpersonal links, which is of positive worth to the members of the society, and identified by the social organisations as trust, norms and networks that can improve the efficiency of the society by facilitating coordinated actions (Dasgupta, 2005). B. Wellman, A. Q. Haase, J. Wittie and K. Hampton (2001), refer mainly two kinds of social capitals expressed in the literature:

a. Network Capital: Relations with friends, neighbours, relatives and workmates that significantly provide companionship, emotional aid, goods and services, information, and a sense of belonging.

b. Participatory Capital: Involvement in politics and voluntary organisations that afford opportunities for people to bond, create joint accomplishments, and aggregate and articulate their demands and desires.

Besides these two, a third item suggested for analysis is:

c. Community Commitment: Beyond interpersonal interactions and organisational involvements, when people have a strong attitude towards community, having motivated and responsible sense of belonging. They will mobilise their social capital more willingly and effectively.

Despite being recognised as an inherited social asset, with respect to resource allocation, social capital has two potential weaknesses: Exclusivity and Inequality. Exclusivity refers to anonymity, which is absent from the operations of network and transactions are personalised. Inequality refers to asymmetric social ties where benefits of cooperation are captured by more powerful within the network (Dasgupta, 2005). D. Parathasarathy and V.K. Chopde argue that social capital in terms of increased ability and willingness to cooperate and work together for achieving common goals, and sustaining development norms and networks for collective action- is crucial for successful uptake, diffusion and impact of innovations.

3.3.3 Social capital and communication structures networks

Generally, a social network refers to a social system constructed by a collection of actors, relations among these actors, and possible attributes for each actor (Assimakopoulos and Yan, 2006). While visualizing any conceptual structures of communication, one needs to understand the typology and pattern of social capital present in the community. Social capital is originated and present within the minds of the people in the form of ordered set of established relationships, which can be further developed in the physical form of 'Community of Practice' (CoP). Considering the social dimensions of knowledge creation, transfer, and management, T. M. Prothmann, (2006) suggests the idea that CoPs can be networked as a social communication process and encourages the sharing of knowledge among the communities. These communities can foster the network building process and e-collaboration among the individuals engaged in the execution of common task. These individuals gathering and exchanging information on an Internet Web sites or linked by group e-mails to discuss topics of common interest is termed a virtual community. Virtual communities also form community of practice when topics of common interest for the community attempted to address. These communities of practice are identifies primarily by three dimensions: joint enterprise, shared repertoire and mutual engagement (Assimakopoulos and Yan, 2006). E-Collaboration with the help of Information and Communication Technology (ICT) can facilitate integration of all these three dimensions of CoPs and makes a valuable asset for the social capital.

3.3.4 Communities of Practice (CoP), Community Network (CN) and Digital Ecosystem[9]

The CoP is one of the ways to understand communities in social science. Communities are a place of collective learning, which result in shared practices. Here, the members are brought together by joining in common activities and learn through their mutual engagement in these activities. The CoP may be formal or informal in nature (Mueller-Prothmann, 2006).

CNs are often called civic networks, Free-Nets or public access networks (Shapiro, 1999). The main characteristic of CNs is that they are computer-mediated, and so CNs are related to ICT infrastructure and services. The different variables using in describing CN are geographically bounded settings, different agencies involved, specified interests, community mission, community activities, computing activities and networked infrastructure. The functions of the CNs are social recognition, emotional support, knowledge sharing, a sense of belonging, self-organisation process and problem solving possibilities.

On the other hand the DE concept would like to provide an interdisciplinary approach to technology design and development and a peculiar process of territorial innovation through community participation and action (Dini, 2007; Corinto and Rathbone, 2007). The DE is oriented toward an Open Source approach in which an open, flexible and scalable

[9] This section draws literally from Deliverable 7.1 of OPAALS Phase I, which has contributed to the development of this research plan in myriad ways.

infrastructure can be used by different people but can not become the owner or take up the power of the infrastructure and thus has not a single point of failure.

Thus, when there is a face-to-face interaction among the individuals of a community for fulfilling some common purposes, it is called CoP. CoPs are commonly constituted through shared work practices over time; but when the interactions are made through some technological mediator then it is called CN, i.e. by introducing digital connectivity within and between CoPs, it can be transformed into a CN. For CNs, existence of digital system is an essential condition but not a sufficient one. The CN can be metamorphosed to digital ecosystem by the inclusion of the concept of self- sustainability.

Thus a computer mediated CoP can be considered as a subset of a CN and CNs can become more interoperable with the help of DEs. DEs can leverage from the open infrastructure developed in the CNs as a gateway to local communities, local knowledge and services. Therefore, the concept of Digital Community Ecosystem (DCE), introduced in OPAALS Phase I, is nothing but an open access infrastructure and software environment that provides the possibility to develop, share, sell and deploy interoperable services that enhance computer mediated communication at local and global levels (OPAALS Del 7.1, 2007).

3.3.5 ICT and communication environments

Information system researchers have generally embraced the importance of recognizing the inherently social nature of appropriation of information and communication technologies (ICTs), greater attention tends to be afforded to work organisation application context[10]. Digital Information Environment (IE) is the social context within which ICTs are designed, implemented and used and digital information is created, accessed, manipulated, stored, disseminated and used. ICTs and digital information are the resources in the digital information environment that are drawn upon and used as the people engage in information behaviours.

Physical communities in the form of formal and informal groups adopt electronic tools and technologies and further, the dynamic transformation in information flow results into evolution of a digital ecosystem. Digital ecosystem describes an ICT enabled network that displays associative and autopieotic properties. In other words, not only is a so defined network capable of self-sustenance, but also of expansion through heightened inclusion (i.e., increasing heterogeneity in the network composition) and growth (i.e., increase in the size and scope of the network). In simple terms, a DE is a web of interconnected and interdependent ICT enabled users who transact in the digital mode resulting in synergistic benefits for all. The strength of this system is that it enables a resilient, multi-user exchange relationship capable of adjusting to change (Sarkar and Rajagopal, 2007). It is also found that use of Internet (modern tool of ICT) increases the degree of associations and interactions within the existing social capital (Wellman, Haase, Wittie and Hampton, 2001). In digital ecosystems, the environment is decentralised, open, and heterogeneous, which facilitates reuse, automatic composition and fosters rapid, low-cost development of distributed applications. A distributed network infrastructure ensures that the responsibilities of the nodes are approximately equal. In particular, there is no distinction between clients and servers as all nodes provide services to each other as peers. This contributes to very high robustness, mainly due to their inherent decentrsalisation and redundant structures. It is also proposed that the ICT interventions take into account a community centric design to improve the sustainability and lead to the evolution of a more complex and multi functional ICT enabled socio-technical system (Rajagopal and Sarkar, 2008).

[10] Information System Innovation, Adoption and Diffusion: 16th European Conference on Information System

3.3.6 Evolution of a knowledge management system

Understanding 'Dynamism' in Knowledge Transformation
Knowledge is intangible, boundary less and dynamic, and if it is not used at a specific time in a specific place, it is of no value. Therefore, use of knowledge requires the organic concentration of knowledge resources at a certain space and time. Knowledge develops operationally in terms of reconstruction at the level of links between the nodal institutions. Knowledge based systems do not exist in terms of stable elements, but they develop in terms of operations which can be combined and recombined in a variety of ways. Knowledge management has introduced the concept of Ba (as a phenomenal place), which means shared spaces for emerging relationships (Nonaka and Konno, 1998). This space can be physical, virtual, or any combination of them, which provides a foundation for creation and growth of individual and collective knowledge. The knowledge transformation process involves four ordered cyclic phases/stages: Socialisation-Externalisation-Combination-Internalisation (Nonaka and Konno, 1998; Novak and Wurst, 2004).

- Socialisation: Sharing of tacit knowledge between individuals through joint activities like being together, spending time, and living in the same environment.
- Externalisation: Expression of tacit knowledge and its translation into more comprehensible forms that can be understood by others.
- Combination: Conversion of explicit knowledge into more complex sets of explicit knowledge through communication, diffusion and systemisation of knowledge.
- Internalisation: Internalisation of newly created knowledge in the conversion of explicit knowledge into the tacit form for specific purpose.

The institutional network arrangements become a background as well as a necessary condition for both producing and retaining knowledge. The system under study operate dynamically, knowledge flows between systems can temporarily be stabilised and further developed along the historical trajectories of institutions that have served the development hitherto. Scientific knowledge is produced in two modes: Mode 1 refers to the traditional shape, largely confined within Institutional settings; Mode 2 is communication driven, contained within an institution or even within an individual agent as 'tacit' knowledge (Leydesdorff, 2003). It can be published and brought into circulation. These dimensions of knowledge resonate with and disturb the established public/private arrangements (Institutional Network Links). New regulations (system design with appropriate hierarchal structure having precisely defined accountability and responsibility) are needed when knowledge-based technologies restructure the sectoral organisation.

Mutual Interaction among the Knowledge Actors
Dealing with complex tasks in a collaborative environment requires shared understanding, shared values and a level of social cohesion, which do not simply emerge in a virtual setting. Social capital present in the form of pre-social disposition of historical social structures amalgamates two strikingly different objects: Beliefs and Behavioral rules, which guide the communitarian relationships among the actors (Dasgupta, 2005). Both, theory and evidence, caution us that communitarian relationships can involve allocations where some of the parties are worse off than they would have been if they had not been locked into relationships structured under an 'equilibrium strategy' of fair social practices (Dasgupta, 2005). The idea behind the 'equilibrium strategy' says that one member of a community is obliged to follow certain set of norms only in the case all other members are following it fairly. The nature of interaction among the nodes of a system highly depends upon this strategic viewpoint. The structural design of a knowledge organisation must consider the driving forces

behind the mutual interaction between their knowledge centers (nodes). The nature of interactions also depends upon the direction and reciprocity of transactions taking place between them.

Creating a Fair Platform
A virtual knowledge management platform with *open access* opportunities can foster the frequency of knowledge transactions between the knowledge nodes. Open access may also enlarge the audience and increase the impact for the contents lying in the public domain by restoring fair use rights after re-evaluating the interest of the members. This system having mutually contributive obligation to open access resource usage may be encountered by several barriers in its development, e.g. 'handicap access barrier', 'language barrier', 'filtering and censorship barrier', and 'connectivity barrier' (Suber, 2004). These barriers can be overcome by digital ecosystem design employing contemporary ICT tools and effective knowledge management system.

Integrated Knowledge Management Systems
In the last few years, the socio-technical perspective has emerged as the dominant paradigm in the information and knowledge management system studies. Knowledge management, characterised by a technological process view, has given way to new approaches that examine the social dimensions of knowledge creation, transfer, and management. Theories explain certain physical constructs like 'community of practice' (Prothmann, 2006), 'community of scholarships' (Bendersky, Kathleen, and Ginn 2007); and virtual constructs like 'knowledge networks' (Prothmann, 2006), 'intellectual geography' (Sawyer and Rosenbaum, 2000), 'shared values', etc. that enables us to characterise the knowledge management system through IT-based, as well as community based approaches. The current trend of development is manifested predominantly in terms of 'modernisation' which is a multi layered process involving economic, social, psychological dimensions and use of sophisticated technologies. Information and Communication technology (ICT) has been emerged as one of the most effective and efficient supporting foundations at which modern social networks and structures can be shaped. Social informatics is one the areas of study that can analyse the social consequence of design, implementation and use of ICT over a wide range of social and organisational settings, and consequently, acts as a feedback mechanism to the knowledge community.

Social Informatics as a construct of a Knowledge management system, involves *normative, analytical and critical* orientations (Sawyer and Rosenbaum, 2000), which may be further combined for any specific study. The *Normative* orientation refers to research that aims to recommend alternatives for professionals, who design, implement, use, or develop policy about ICT. The *Analytical* orientation refers to studies that develop theories about ICT in institutional and cultural contexts or to empirical studies that are organised to contribute to theorising, that can be further generalised to other ICTs and settings. The *Critical* orientation refers to examining ICTs from perspectives that do not automatically adopt the goals and beliefs of the groups that commission, design or implement specific ICTs. It encourages the information professionals and researchers to examine ICTs from multiple perspectives and to examine possible failure modes and service losses. ICT embedded social informatics facilitates building relationships between ideas, concepts and findings that may later appear in the virtual form of 'Intellectual Geography', which gives recursive technological push upon the communication patterns.

A knowledge management system can be considered to be composed of several actors with their individual attributes. However, for the sake of simplicity of understanding in the context of structural design, actors can be reconsidered and redefined as elaborated in Actor Network Theory (ANT) (Tatnall and Gliding, 1999). ANT is based upon three principals:

1. Agnosticism: Analytical impartiality towards all the actors under consideration.

2. Generalised symmetry: To explain the conflicting viewpoints of different actors in the same term by using neutral vocabulary that works the same way for human and non-human actors. Neither the social elements nor the technical elements of the heterogeneous network should be given special explanatory status.
3. Free Association: This principle requires abandonment of all a priory distinction between the technological or natural, and the social.

Similar more concepts can be taken into consideration to develop a comparative framework for our theory building approach.

3.4 Theoretical framework

Since operational systems that communicate knowledge cannot be considered as given or immediately available for observation, it is needed to specify them analytically on theoretical grounds before they can be indicated or measured. To this end, quantitative measurement is completely dependent on qualitative understanding. The theoretical framework that guides T11.3's research, determining what things it will measure, and what kind of relationships it will look for, mainly depends upon observations taken from the knowledge management project under NAIP, coupled with frameworks and the conceptual variables extracted from literature. We will thus have to follow a grounded theory approach. The underlying conceptual structure will basically address the knowledge perspectives of 'evolution, recombination and reconstruction', 'similarity and differences', 'continuity and change', and 'dominance and subsidence' of the networked knowledge creation and sharing system. The study will be focused primarily around observing four main conceptual dimensions including time horizon under the stated context and perspectives. These are:

1. Community of Practice. This term relates to the 'system of actors' or the part of historically existing patterns of 'social capital' that are predominantly responsible for generation of contributed contents.
2. Community of Scholarship. Within this community, basically the system of actors considered are the 'interdisciplinary knowledge workers' brought under a common interface, which are predominantly responsible for generation of the commissioned content.
3. Knowledge Management System. This dimension is envisaged as an open and democratic system, where actors are pulled from both of the above mentioned communities in order to create a mutually reciprocative and all kinds (tacit and explicit) of a knowledge creation system. This system is composed of two separate entities with their individual nature and characteristics: Actors, and Networks.
4. Time axis. This dimension will study the nature of entropy intended to be established among the above three concepts considering them as overlapping physical blocks. This will eventually give an assessment idea about the expected nature of mutual interactions and help to figure out the measurement indicators for evolving the optimal system design.

Derived from literature review, the basic conceptual approaches used for this research are:

- Nonaka's Model of Knowledge Creation and Sharing
- Social Capital Analysis
- Communication Network Theory
- Actor Network Theory: Innovation and Translation

Similar more conceptual elements are supposed to evolve at the later stages of research.

3.5 Methodology

The output of research in T11.3 has to be aligned with a theory building for communication structure design for a knowledge management system, and it has to be justified at a certain set of empirical measures. The methodological approach adopted for this research is based upon **Grounded Theory** (Glaser and Strauss, 1967; Pandit, 1996; Haig, 1995), which is dependent upon its process of generation. That seems to be best suitable in order to accommodate the action research procedure where the researcher is the part of the system under consideration. The Grounded Theory approach emphasises the development of constructs, measures, and testable theoretical propositions; makes inductive case research consistent with the emphasis on testable theory within mainstream deductive research (Eisenhardt and Graebner, 2007). The most important feature of this theory, which is based upon 'data' is that, it can usually not be completely refuted by or replaced by another theory as it is too intimately linked to the data; and it is destined to last longer despite its unenviable modification and reformulation (Glaser and Strauss, 1967). Concepts are the basic units of analysis and are collected from reports of research studies and theoretical and philosophical literature, paper characteristics of professional and disciplinary writings (Stross and Corbin, 1990); which will guide to interpret the collected data, phenomena or evidence to the conceptual level. Data and phenomena are two separate concepts that need to be distinguished. In qualitative research, 'phenomena detection' can be taken into account instead of data collection, and grounded theories can be grounded in phenomena, not data (Haig, 1995).

The first step to be followed in the research begins with strong grounding in literature, identifying gaps and proposing research questions that address these gaps. The basic strategy used will be theory building from cases. The next step is the theoretical sampling of cases, which are suitable for illuminating and extending relationships and logic among the constructs. Cases will be selected for the likelihood that they would offer theoretical insights, such as revelation of a usual phenomenon, replication of findings from other cases, contrary replication, elimination of alternative explanations, and elaboration of the emergent theory. Emerged theory will be developed and generalised until it reaches a certain saturation level.

3.6 Expected outcomes

The expected outcomes of the research effort would lie along the following lines:

- Theoretical insights on knowledge creation and sharing
- Depiction of Social Capital Pattern
- Typology of network structures
- Methodology to compare the quality appropriateness of the commissioned and contributed content

3.7 Conclusion

The aim of this research is to foster a knowledge driven growth process through collective learning in the context of the Indian Agricultural Domain. The IITK team would like to contribute towards developing a knowledge management framework for building a digital knowledge ecosystem. Therefore, the focus is to study the different forms of existing social capital under the perspective of networks, identify the knowledge actors with their specific functionalities, and the nature of communication observed among them. This would contribute towards the OPAALS objective of developing an integrated theory of digital ecosystems. The research will also attempt to ucover the enabling factors that can ensure the long-term growth of digital ecosystems in the present socio-economic conditions, specifically pertaining to agriculture.

Chapter 4

The Dialectics of an innovation network applying the OPAALS framework in the context of Development: Objectives, Methods and Theoretical Orientation[11]

This Chapter represents a first step towards the deliverables that ITTK will develop in the context of T11.4 in month 36, which will focus on:

- The development of a theoretical framework for understanding autopoiesis of the socio – digital space.
- The role of social informatics and social media in organising large-scale social innovation.
- The effects of intrinsic and extrinsic rewards on knowledge sharing behavior in a digital ecosystem.

The biological concept of autopoiesis (Maturana and Varela, 1980) and the philosophical concept of meaning were integrated in the work of Luhman (1995) to develop the sociological construct of autopoiesis. Inspired by a text about DonQuixote's dialectical problem of choosing between the path of praxis (action) and the path of poiesis (creation, production) Maturana and Varela created the term 'autopoiesis'. The term embraces their central dialectics of all living systems that is 'cell metabolisim produces components which create a transformational network for transforming the metabolism itself' (adapted from Maturana and Valera, 1998:44).

The term autopoiesis thus, implies that any organism consists of many components and it continuously recreates itself through its components. Every component creates (or takes part in a creation process of) other components, which themselves create again other components and so on. In a living organism, this creation-process is closed, that means all components create each other in a circular organization without help from the "outside". Varela proposed two conditions to formalizes the term autopoietic: (a) all components continuously produce each other (circular organisation) and (b) one or more components build a border of the organism so that the whole system is closed and can be recognised as single unity (structure).

Luhman, while applying autopoeisis to the social context, considered that social systems use communication elements to operate with meaning and thus communication is the elemental reproduction and transformational unit of social systems. His copnceptualised social communication system has a dialectical unity of three parts; information, utterance and understanding (Buchinger, 2006:365-366).

Thus the digital ecosystem as a socio-digital system can exist only when communication creates more communication through the dialectic interaction between the possibilities created in the inquiring minds of the actors with their actions in the same temporal frame.

This study into the inquiry systems of actors in a socio-technical transformation process is the framework of task 11.4 in the context of innovation and deployment in the agricultural domain for socio economic development of North Indian regions.

For now, we will first introduce the background of the agricultural domain in India and the new challenges it is facing. We will then delineate the research and the methodology to be used.

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4.1 The Indian agricultural domain

Indian agriculture is today at a cross road: after forty years of 'Industrial agriculture' based on 'high input technologies', i.e. heavy usage of chemical fertilisers and pesticides with copious use of irrigation, water enhanced production initially, but created many bad side-effects in the long run (see D7.3).

Initially, the so-called 'green revolution' was successful. The country attained self-sufficiency in several crops and across most of the constituent states of India. But the yield growth rates of the 60s and 70s soon reached a plateau, and declined during the 80s and 90s.

Many new diseases, pests and weeds came with imported high yield hybrid varieties and the manipulated hybrids. Beside this, the knowledge advancement showed that some techniques, such as the copious use of irrigation, could end up in soil impoverishment. In this scenario, knowledge creation and sharing, together with new technologies, can play a big role to retrieve growth.

Innovation in Indian Agriculture at every stage of the value chain, from seed to food processing, is a national priority. India needs to innovate and develop its own version of post-industrial agriculture that can effectively meet the new challenges.

4.2 Antecedents of innovation diffusion

Central to the study of innovation diffusion is the understanding of diffusion as a process of social change entailing alterations to a socio-technical system in terms of its structures and functions through communication (Rogers, 1995; Burkhardt, 1994).

Key aspects of the 'diffusion of innovation' processes are thus the 'dialectic' interaction among the 'innovation itself', the 'social system' in which the innovation is introduced and the 'communication channels' through which the social system 'members' learn about the innovation and the 'timing' of the processes.

The earlier research however pays little attention to how these aspects of innovation come together when 'digital channels' are used beyond 'social proximity'. Social proximity facilitates community building needed for social information processing that propagates innovation diffusion (Rice and Aydin, 1991).

In a Digital Ecosystem deployment (for creating the Agropedia, as explained in Task 11.3) we however want to go beyond the usual proximity or "the extent to which one could be exposed to social information in a given social system" (Rice and Aydin, 1991).
Social proximity has been demonstrated to have significant impact on knowledge sharing and innovation in agriculture (Hayer-Strand, 1976) or biotechnology (Owen-Smith and Powell, 2004). There are three types of proximity: spatial, relational and positional.
In this research we will focus on the spatial and relational proximity to study the innovation propagation through e-collaboration that uses Luhman's concepts of autopoietic communication based on circularity, maintenance and reproduction.

4.3 Research focus

The research under task 11.4 will thus focus on the many dialectical processes and questions arising there of, as to how, self-managed and self-propagated communication reproduction takes place when in a way that communication destabilises the socio-technical system itself that generates it.

That is, how the current Agricultural Extension system in India will propagate innovation that will target to change that extension system itself. There will be many interesting dialectics to study in this complex adaptive scenario, like collaborative tasks versus the mediating technology; or the individual expert's mental model versus the community knowledge model (Zigurs and Buckland, 1998; Kock, 2004).
Other interesting research threads that we intend to explore are:

No.	Research issue	Theoretical perspective
1	Types of contextual information needed to make a repository more useful in a knowledge system	Context networking Domain taxonomies
2	Optimal blending of mode and media for different e-collaborative tasks and processes	Media richness and channel expansion theories Task technology fit theories
3	Measures and methods to study user acceptance	Adaptive structuration theory
4	Balancing user experimentation and flexibility with procedural guidance and standards	Reward system in collaborative virtual environment
5	How integrated e-collaboration behavioural patterns develop and are sustained	Innovation diffusion Change management
6	Embedding structures in system for effective appropriation	Service quality and gap models
7	Identifying conditions for preferred sequence of digital collaboration and incorporating emerging technologies into existing infrastructures	
8	User satisfaction and quality of service for an e-collaboration platform	

Structured conflict and consensus approaches have been used in earlier research on e-collaboration (Fjermestad, 2007). Our field studies at the various partner institutions of NAIP (the National Agricultural Innovation Programme) will address the research issues based on the theoretical aspects described above through the Dialectical Inquiry method.

Structured conflict procedures such as Dialectical Inquiry (DI) have been shown to decrease process losses and improve the outcome in groups (Schweiger, Sandberg and Rechnere, 1989). Experimental or longitudinal studies have demonstrated that DI and similar structured conflict approaches such as 'devils advocate' (DA) procedures can improve group knowledge outcome and complex decision quality (Mason and Mitroff, 1981; Mason, 1969).

However, such studies have not been done earlier in the e-collaboration field and among digital communities as planned here.

4.4 Research design

Given the current infancy of research into Digital Ecosystem as Knowledge Communities and repositories, the deliverables of Task 11.4 will be based on studies on knowledge workers' (in this case Indian Agricultural Scientists' and agricultural extension workers') inquiry system, knowledge contribution and knowledge usage practice.

It is expected that by studying the comparative merits of Dialectical Inquiry (DI) and Constructive Consensus (CC) as processes, results of this research will be useful to practitoners to formulate suitable design for the socio-digital space that can accommodate the inquiry modes of different knowledge workers and encourage participatory behavior.

If it is clear how knowledge workers in a DE approach learning innovational new ways in old legacy systems (like agriculture) it would be easier to evolve better designs for knowledge sharing and creativity in open knowledge systems (OKS).

Survey instruments, interviews and observational camps will be used to understand the inquiry modes of Indian Agricultural scientists.

The logical structure imposed by DI requires us to identify competing models and explore them in depth. These models will emerge from the Agropedia users/respondents. By applying this methodology, comparison will be possible, in a qualitative way, between the two models of knowledge production and exchange: the 'paid-for' model and the 'co-creative contributory' model. This comparison will drive an evaluation of the effective capability of the two systems in supporting the knowledge creation and knowledge exchange and their specific potentiality for a development sector, such as the agricultural realm in India.

Chapter 5

The Digital Ecosystem Impact Index as a first step towards a multi-stakeholder policy framework for regional economic development: objectives, methods and theoretical orientation[12]

The general objective of WP11 is to develop a methodology that can bridge the necessarily theoretical deliberations surrounding the Digital Ecosystems concept with the practical concerns of regional development policy.

Task 11.5 deals with the most practical deliberations, focussing on the development of a multi-stakeholder policy framework, pivoting first on the development of a methodology for assessing the socio-economic impact of Digital Ecosystems deployments, through the Digital Ecosystems Impact Index (DEII). One of the main implications of the DEII is to secure greater transparency of the OPAALS and public confidence on the DEs.

The DEII will provide a systematic and professional assessment of the DEs deployment. Nevertheless, if DEs research is meant to be linked to public policy, through the DEII, one has to start with policy as a base for determining the kind of DEII – or research clarifications- needed by 'policy-makers'. Communication and interactions among the policy-making and the research worlds are then central in the process for developing an effective, scalable and flexible DEII.

The mutually suspicious worlds of policy-making and research

Scientists and 'policy-makers' are commonly following different paradigms and approaches (Bartzokas et. al., 2000:28) leading in communication difficulties, and different recommendations and priorities. On the one hand, policy-makers are generally exclusively preoccupied with short-term outputs and impacts and are often looking for clear and practical answers and recommendations that help them in solving emergent problems (Mény, 2000:65; Bartzokas et. al., 2000:28). As it will be discussed, the DEII will serve partially for this use by policy-makers, as a tool for 'evidence-based' policy formulation. On the other hand, social scientists focus generally on different effects and start investigations once an issue or problem arises (Bartzokas et. al., 2000:28). This is the case of the DEII, born as a necessity raised by the EC after tracking a gap between research and DE as a regional development tool as understood by policy-makers.

WP11 research is meant to reconcile the mutually suspicious worlds of policy-making and research, preventing that the OPAALS project cultivates an 'ivory-tower' syndrome (Mény, 2000:68) and thus, loses track of reality, triggering its policy applications and links to sustainable regional development as per its philosophy.

5.1 DEII research, policy and complexity

Policy needs are continuously changing (Sloan, 2006:43). The process in which research related to innovation processes is linked to policy formulation is characterised from being highly complex and non-linear, just as the innovation process. The policy-making mechanisms vary significantly from country to country, even from region to region in a given country, because the institutional structures are very different (not only in terms of the institutional structure but also in terms of the political tradition, level of development, productive fabric, etc.). Additionally, when calling for a methodology for impact assessment of the DE, and considering the DE as enabler of changes of the 'techno-economic paradigm' as per Christopher Freeman's (1987) taxonomy of technical change, we come to the partial conclusion that, due to 'technological determinism' there is the impossibility to argue that there is *an* (sole) impact linked to DE deployment, but rather different impacts that are inherent to the socio-economic-policy framework of the region/territory of application. When

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deciding to deploy the DE, there is inexorably a two-fold mechanism related to public policy, since once the DE is deployed, further changes will appear in the course of the paradigm transformation as argued by Freeman, and new policy adaptations will be needed. The process in itself inexorably requires interactions and feedbacks between the social science research world and the entities (public and private) involved in the policy making process in order to be effective. Nevertheless, co-operation between researchers, policy-makers and stakeholders involved in policies is not self-evident (Henke, 2000:10), and once again, the practice of the co-operation is highly determined by institutional settings.

This section is interested in exploring the mechanisms that promote the interface between measuring the socio-economic impact of DEs deployment through the DEII, with policy. In this exercise, the understanding of 3 key-mechanisms is central:

- *Understanding the innovation process*, through the existing policies and the policies that are missing and that are needed in a given setting.
- *Understanding the interface with policy users*. A definition of the users (DEII policy-users for instance) and a clear understanding of *who* the 'policy-makers' are. Because the process of regional development through innovation is complex, it becomes clear that it is no longer true that policy-makers are just the group of politicians in government, but rather a complex system that involves many institutions and players and the linkages among them (Sloan, 2006:44).
- *Understanding user needs*. Ensuring that the DEII, through its multiple-accounts and qualitative/quantitative data is useful and relevant to its multi-stakeholders, serving (partially) as a tool for policy analyses.

Comparison is a fundamental incentive for policy entrepreneurs (Mény, 2000:69). Research mechanisms and tools are very often necessary to understand the dynamics occurring in a given situation, as evidenced by the recent importance of evidence-based decision-making (Renaud, 2000:62). Information and data (qualitative and quantitative) availability that provides a systemic and comparative framework for solving the rather 'problematic' question of DE deployment is crucial, especially because there is normally a desire of the entity financing the deployment in assessing the costs and benefits of its investment. Nevertheless, given the complex mechanisms envisaged and defined above, it is also a major duty of T11.5 to ensure transparency and objectivity in the assessment process. It is a primary duty of this task to ensure that the general methodology, the methods of collection, and the interpretations, are not influenced by the interests of the involved stakeholders. This has implications that will be revealed by the limitations of the DEII tool.

5.1.1 DEII use by policy-makers

De Gier (2000:109) identified four interacting factors as the basis for the public policy process: interests, ideologies, information and institutions. This results in three different kinds of possible utilisation of the DEII by policy-makers (based on the classification by Henke, 2000:5 on Knowledge Utilisation Studies).

- **Instrumental** use for DE deployments. This will happen when there is a political consensus between policy goals and the DE net benefits, as evidenced through the DEII, provided by the region. Additionally, the capacity (financial and operational) to implement/deploy has to be available.
- **Conceptual** use. The DEII will introduce ideas and theories that might influence the political agenda and discourse. In this case, the DEII will provide an important contribution for more effective policy-making, helping to strengthen policy areas that are difficult to accept or are unclear from a social and political point of view. It can be seen as the preliminary step to instrumental use when there is no political consensus between policy goals and the DE net benefits as per the DEII.
- **Warning.** The DEII might be used to move items up (or down) in the political agenda. In this case, the DEII will draw policy-maker's attention at an earlier stage, concerning possible criticisms of a given issue related to the regional/local development process.

'Warning' use is required when there is the willingness of forthcoming an instrumental use, but the capacity (financial and operational) is not present in a given setting.

In all of the three cases, the DEII will be seen as a tool for 'evidence-based' policy-making. The argument is that while being able to map the value of the net benefits related to DE deployments, policy-makers will find it easier to decide on a *use* within the referred territory. In order to understand the type of use that is to be given to the DEII, one has to look also at the implicit and explicit motivations of policy-makers to turn to DE knowledge through the DEII.

5.1.2 Speculation and policy-making: the limitations of the DEII

Evidence-based policy-making entails a recurrent paradox: policy is about the future, while evidence is about the past (Rip, 2000:96). The DEII will necessarily use data that is related to the past, while its assessment is intended to support decisions about the future. A great deal of diagnosis, inference and judgement will be needed when building the assessment methodology, all of which contain a high element of speculation. Additionally, DEs 'evidence', in its strict sense, is way too limited at the moment to serve as a basis for policy-formulation.

To be effective, DEII policy-users would have to make use of DEII data taking into account these limitations, as well as the probable responses of the rest of the stakeholders. DEII evidence should be part of the 'plot', but by no means it should be its only master (Rip, 2000:100). Additionally, the presentation of evidence as per the DEII and its use in policy, might affect perceptions and behaviour, which would in turn undermine the value and significance of the original evidence, and thus changing the system. Once again, several iterations between the policy and research world are needed, and a great amount of precaution has to be taken when drawing conclusions. This is primarily due to the fact that, in this stage, we cannot rely on observation-based data being the DE in a development phase.

5.1.3 Key elements for guaranteeing DEII effectiveness and usefulness: towards the efficient link between DEII and policy

The above discussion raised the importance of two key elements that will determine the effective link between DEII evidence and policy: communication, dialogue and interactions between the research and policy worlds; and knowledge dissemination and utilisation of the DEII among policy-makers. Both of them, as explained before, are to some extent out of the scope of Task 11.5, but they have to be underlined in order to prevent out-of-scope or over expectations by policy-makers.

The reality is that the DEII will only be sustainable if the information does not flow in only one direction. This is partially the case of Task 11.5 that just considers one iteration with the policy world through a focus group and a single fine-tuning mechanism. The DEII should entail an open interaction and meeting of minds through the development of mutual trust among the research and policy worlds. Through this task, it should be guaranteed that the initiator capacity for starting this dialogue is reached by the OPAALS research community. It will be crucial to identify the ideal receptor and its capacities for enabling an open and interactive dialogue.

Knowledge dissemination and utilisation by policy-users of the DEII is also essential for guaranteeing sustainability and effectiveness of the assessment methodology. This refers also to dissemination activities that would make policy-makers interested in the DEs, know about the DEII. These activities could be facilitated by the interaction of the OPAALS with other projects, first of all with the DEN4DEK project, dealing with dissemination activities of the DE Initiative and that have more direct contact with regional stakeholders and policy needs.

Some preliminary conclusions

The DEII is to be seen as the first step for enabling interaction between the OPAALS and the policy-making world by regional stakeholders. It will end in a multi-stakeholders framework that could be seen as the hints for 'distributed intelligence', because all the relevant information and knowledge that will comprise the DEII are distributed across regions, actors and settings. The DEII will conclude in an integrated assessment model, whose outcomes must be internalised as a part of a particular environment (social, economic, politic and institutional) that will differ from user to user, as its policy use and usefulness will be context dependent.

5.2 How to conciliate the concept of Impact with the ecosystemic approach?

As described above, one of the instruments to be developed with the purpose of bridging the research realm with that of policy-makers, is the Digital Ecosystem Impact Index (DEII).

The DEII is intended to be, first of all, a methodological process supporting policy-makers in evaluating the socio-economic outputs of the Digital Ecosystem (DE) approach at local level. Such an instrument is aimed at providing policy-makers and other local stakeholders with a clear view about what kind of effects (and trade-offs) the implementation of DE will produce in their socio-economic environment.

As it will be shown, the development of the DEII will face a series of methodological challenges. The first one, in order of generalisation, is the difficulty of conciliating the very concept of "impact" with the ecosystemic approach. The following paragraphs will try to describe such a challenge, involving a careful literature review that will be part of Task 11.5 activities. This first methodological challenge will be delineated by a comparison between economic theories. This will end up in positioning our research (Rosaldo, 2002) within this theoretical panorama that will conceptualise a research agenda based on the concept of 'economics of complexity[13]' (Martin and Sunley, 2007; Hodgson, 1993; Lawson, 2003).

Generally speaking socio-economic impact analysis has a scarce visibility and a reduced acknowledgement amongst policy-makers (and to some extent amongst scholars) if compared with Environmental Impact Assessments and Cost/Benefit Analyses (Bellinzoni, 2005; Bresso, 1991; Beato, 1991). This is caused by various reasons: the novelty of such an approach, the lack of a standardised methodology and the difficulties in developing one[14]; a general scepticism about the relevance of the social aspect of an innovation process and local development (conceptualised as soft) and the complexity of elaborating a methodology that needs to be genuinely interdisciplinary (at least cross-disciplinary between sociology and economics). Beside this, with reference to the social side of the impact analysis, it must be remembered that forecasting represents a slippery ground for sociology (Amendola, 1989;

[13] The term 'economics of complexity' does not refer to a well defined school of thinking but, more likely, to an arising field of research that aggregates scholars from different sub-disciplines and that finds in complexity theory a source of inspiration. As Martin and Sunley explain (2007) "*This expanding interest and increased participation in the discourse of complexity has not yet resulted in any clear, precise or generally agreed definition of the term. However, the reference to complexity theory is perhaps to exaggerate the degree of conceptual coherence and explanatory power associated with this notion*" (ivi: 3). It is possible to track some 'debits' that complexity economics has with other theories: first of all natural and physical complexity theory (Nocoli and Prigogine, 1997) and then, in economics, with evolution economics (Nelson and Winter, 1984) and with neo-Shumpeterian theories (Dopfer and Potts, 2004b; Hodgson, 1993; Hanusch and Pika, 2005 but also Shumpeter, 1911 and 1942).

14 This difficulty derives, as we will see, from the centrality of the context in this kind of research. It is very difficult to select a series of variables able to describe in a sensitive way two or more territories or situations. Consequently, most of the time, it is necessary to develop an ad hoc measurement instrument for each territory and for each phenomenon under study. It will be tried to develop a sensitive, open and adaptative methodology able at the same time to allow, at least partially, comparability, and at the same time assure a personalised vision of each context.

Bartzokas et al., 2000). As mentioned above, (see section 5.1) social sciences are more interpretative (of 'something' that already exists) than predictive. This represents an obstacle in the development of a shared vision for socio-economic impact analysis.

Nevertheless, the attention and the expectation about socio-economic impact analysis are growing at international level. For example, in 1986 the World Bank introduced it in its evaluation processes, and in 1994 the United States government did the same.

The relevance of the socio-economic impact analysis for policymaking and local planning pushed us towards the development of a model able to tackle the DE deployment. But we need to 'build up' a dedicated definition of socio-economic impact analysis, because the concept of 'impact' seems to be problematic when referring to DEs.

The concept of 'impact' recalls the image of an object striking against another; a body (or in a figurate term an idea, an innovation, etc.) that moves with a given force against and *on* another body. It echoes a one-way process that involves two (or more) clearly separated objects one of which acts on a non-acting one. The concept of impact is, in other terms, mainly mechanistic, i.e. it suggests a 'vision of reality' based upon a linear cause-effect structure of explanation. The ecosystemic approach, to the contrary, can be understood as a holistic approach that does not explain the 'reality' in terms of the combination of its components. Moreover, in the mechanistic approach, a system can be understood by observing separately the ways in which its basic components do operate. In the holistic approach, the system is more then the sum of its components and its basic elements are engaged in continuing feedback mechanisms that are far from linear. Consequently, it will not explain a phenomenon as the output of a single, clearly identified input. This is a first crucial difference.

In social sciences[15] the linear cause-effect model of explanation has been strongly criticised, firstly by Merton and then, particularly, by post-structuralism and social costructuvism (Faucoult, 1966 and 1969; Berger and Luckmann, 1966) and by the theory of complexity (Bateson, 1977). Merton, for example, in criticising Parsons (who describes the society in terms of functions and of institutions that carry out specific functions) demonstrated that each social function can be carried-out by many institutions and that each institution has different functions so that the 'one to one' relationship between a cause and an effect was ineffective in explaining social processes[16]. In the DEII this statement is taken for granted. In other terms, the methodology to be developed will not conceptualise the DE as a cause that produces one effect, but as a series of socio-economic and socio-technical processes that influences many, different and interconnected actors and pre-existing phenomena. It will delineate a model in which the DE implementation depends on one hand on a pre-existing socio-economic process and, on the other hand, influences and modifies it.

The hypothesis is that complexity economics is more appropriate than classical and neo-classical economics when dealing with digital ecosystems. The possibility to fully integrate this view in a methodological tool is part of our research agenda. This deliverable is only a first attempt to outline some basic thoughts.

The table below (Table 5.1) describes the main differences between a mechanistic vision of the socio-economic process (traditional economics) and a complexity-based one (complexity economics). As seen, complexity economics are in line with the post-structuralistic approach of social science. Thus, it is easily linkable with the approach used so far in the OPAALS project and in DE research in general.

[16] If there exists an agreement on such a position in social sciences, it cannot be said that this is the case for economic sciences. Classical and neo-classical economic theories are, mainly based on mechanistic metaphors. As it will be seen, other paradigms arised in recent years in economic sciences, and the complexity concept is being discussed in the discipline debates.

Table 5.1 –Basic dimensions that differentiate complexity economics from traditional economics

	Complexity Economics	Traditional Economics
Dynamics	Open, dynamic, nonlinear systems, far from equilibrium	Closed, static linear systems in equilibrium
Agents	Modelled individually; agents use inductive rules of thumb to make decisions; have incomplete information; are subject to errors and biases; and learn and adapt over time	Modelled collectively; agents use complex deductive calculations to make decisions; have complex information; make no errors and have no biases; and have no need for learning and adaptation (are already perfect)
Networks	Explicitly models interaction between individual agents; networks of relationships change over time	Assumes agents only interact indirectly through market mechanisms
Emergence	No distinctions between micro and macro-economics; macro patterns are emerging results of micro-level behaviours and interactions	Micro and macro-economics remain separate disciplines
Evolution	The evolutionary process of differentiation, selection and amplification provides the systems with novelty and is responsible for growth in order and complexity	No mechanism for endogenously creating novelty or growth in order and complexity

Source: Beinhocker, 2006 quoted in Martine and Sunley, 2007

Synthetically, complexity economics define the economy as an "open, non-linear system made up by agents with bounded rationality, who learn and adapt; who interact through constantly changing networks; whose micro behaviours and interactions are the source of emergent patterns and order at the macro-level; and who are a source of constant novelty that imbues the economy with its evolutionary momentum" (Martin and Sunley, 2007:8).

The following paragraphs elaborate further some of the above listed elements. Then, their possible use in the DE research field is envisaged.

- *Single agents vs collectively modelled agents.* Socio-economic processes are characterised by focusing on the choices and the interactions of single agents. In complexity economics, the role of concrete human beings (instead of modelised, abstract, agents) is recognised and it finds a room for analysis. By using the metaphor of networks, complexity economics opens up to recognise social actors as playing a central role in spreading innovation because of their position in the social networks (Granovetter, 1979 and 2007; Porter, 1998). Consequently, knowledge exchange and learning processes are strongly related to social interaction and are crucial for innovation. To the contrary, in classical economics, technology or innovation in general is postulated as universally available so that everyone can benefit (given some pre-requisites) from it. This level of abstraction can hardily explain why in a given territory some sectors (or enterprises) are innovative and some are not (Malerba, 2003; Kim and Nelson, 2000). It does not either recognise the power assymetries (and access to knowledge disparities connected to it) that are central from a post-structuralistic perspective (Foucalt, 1966). The network

methaphor and single agent model seems to provide a better starting point when analysing innovation and technology diffusion.
By making reference to the complexity inspired model, it will be possibile to interpretate the macroeconomic patterns as dependent and generated by the microeconomic level. Additionnally it will be possibile to recognise the centrality of social networks and of social capital, as well as to introduce the problem of knowledge exchange and barriers to exchange as important elements in local innovation analysis.

- *Bounded rational vs fully rational*. The economics of complexity recognise a strong relationship between cultural aspects and the economic phenomenon: the cultural can influence the economic and viceversa. Such an approach is based on the interpretation of social actors/agents (and the institutions) as bounded rational. This highlights the vision of social embeddedness of economic interaction that is crucial when studying innovation processes (Polanyi, 1944; Sahlins, 2000). Moreover, related to the idea of an agent within the bounded rational, the concept of path dependencies emerges[17] (Nelson and Winter, 1982). Economists use this term not only to say that "history matters", but also to underline that it is possible and necessary to consider past experiences and previous choices of actors in order to understand if an innovation will take place and in which way. The phenomenon of path dependency has been especially studied in technological innovation analysis, but it is also useful in analysing the capability of public administration to spread innovation. For example, SMEs in a given territory will resist to open up to innovation that is sponsored by an administration that in prior situations failed in providing a concrete benefit to them.

  Making reference to the complexity inspired model will allow to: give place to habits and norms that might influence single agents in different ways, as well as to generate different effects in different territories. Additionally, this will give place to the emergence of path dependencies processes.

- Innovation is endogenous *vs* innovation is exogenous. Another important element of distinction comes from the effect of modelling innovation as an exogenous process in classical economics. Describing the critics behind this postulation is out of the objectives of this Deliverable (see Grossman and Helpman, 1994). Nevertheless, it can be said that a DE understands technology as socio-technical process linked to different social processes through a feedback loop. Technology is not external to society but is a product of it that, at the same time, is able to modify it through a self-reinforcing mechanism.

  Making reference to the complexity inspired model will allow to: be coherent with the DE vision of technology seen as a socio-technical process, highlighting those local factors/actors that might play an important role in fostering and supporting the uptake of innovation.

The relevance of non-linear models for characterising DEs was already introduced, and the limitations of the term 'impact' within such respect. Another important element of analysis is the openness of the system. When looking at the impact of DEs, it is important to define in which system such impact will be analysed. As it is outlined below, the impact is considered on different typologies of actors/users and on the territory.

[17] The concept of path dependencies shows important points of contact with the concept of network effects. The diffusion of a technology is strongly influenced by the number of people using it and the capability of those users, thanks to pre-existing social links, to diffuse it further. It is possible to say that the number of prior adopters is a term in the value available to the next adopter and it will influence the agents' choices to accept or not accept the innovation.

5.2.1 First attempt in defining a territory

How can a territory be defined from a socio-economic point of view? Can the territory be seen as a system? If yes, is it an open or a closed system[18]? Here, another limitation of classical economics becomes clear: classical economics describe the territory (a region, a city or a country) as a closed system. Complexity economics seem to have a different position, even if there is not a clear general agreement amongst authors.

By relying on complexity theory and on the post-structuralist approach, a territory can be defined as a localised system of social interaction, where economic interaction/exchange is a special typology (Florida, 1998). By using the network metaphor, it must be agreed that the territory is not a closed system[19]. In fact, the limits/boundaries of a network are not pre-determined, but are the outputs of constantly changing social interactions.

If the focus is on the network aspect of the territory, the boundaries would be defined together with local stakeholders, welcoming the definitions proposed by the territory's protagonist. The definition of a territory is going to be understood (following a post-structuralistic approach) as a social process and a process of reduction of complexity (Luhmann, 1975). As a consequence, the territory of focus and of application for the DEII does not represent a self-evident reality outside the social actors. This will arise from their definition and it will correspond to a set of social interactions (networks)[20].

Some preliminary conclusions

Some preliminary conclusions coming from the debate of the above sections are:

- The focus will be on the specificity of the territory; i.e. an open and adaptive methodology for a socio-economic impact analysis will be developed. Innovation is not understood as a process driven by 'natural forces' but as a highly social, historical and institutional process (Martin and Sunley, 2007);
- The DEII will not be a deterministic model, neither it will be based on linear cause-effect mechanisms. It will be as sensitive as possible to feedbacks and interdependencies between actors, institutions and a constantly changing context;
- The territory is understood as a localised system of interaction in which the network metaphor will play a central role. This recognition will support the analysis of the role of social capital and knowledge exchange as relevant elements for local innovation;

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18 These questions must be answered because evaluating the impact of DE means analysing the way in which it might influence the dynamics of a territory, that in this case is *where* the DE will be implemented. This comes from the fact that a DE can be defined as a process of local innovation (Passani, 2007). Currently, the role of local stakeholders is recognised as crucial in fostering and supporting DE implementation. In the future, when users and services will populate the DE, its implementation could be based on different mechanisms and the territory would possibly become only one way of access. In that case, it will be necessary to analyse the impact of DEs on its single users (SMEs, researchers, public bodies, universities, etc). For now, the territory is a vital starting block for DE implementation. Moreover, policy makers are connected within this specific level of analysis.

19 This might cause some inconsistency with the ecological approach, especially when looking at the concept of autopoiesis. As stated by Maturana and Varela (1981)"[…] the space defined by an autopoietic system is self-contained and cannot be described by using dimensions that define another space" (viv:89). Similarly, in social science, Luhmann understands society as a closed system where it is possible to observe many sub-systems inside (Izzo, 2005:447).

20 This is also consistent with the acknowledgment of the centrality of the observer by the autopoiesis approach: "Anything said is said by an observer" (Maturana e Varela, 1980:8). It is the self-reflexive compatibility of the observer that defines what a system is and that conceptualises its boundaries, at least to some extent. This is a research point that needs to be analysed deeper in the following months in order to verify the consistency between the autopoietic approach and the post-structuralistic (social-constructivist) one of social science.

- The centrality of the context is recognised. The concept of path dependencies will possibly be introduced in the DEII. The approach given to path dependencies is not merely economic or technological but it rather recognises the relevance of cultural aspects in shaping local innovation. This is linked to the idea of social embeddedness of economic activities (Bourdieu, 1997; Granovetter, 2007).

The first model of the DEII that is described below represents an important step towards the general aim of introducing complexity in an easy-to-use, transparent to users and sensitive instrument for socio-economic impact analysis of DE implementation.

5.3 A research agenda for an open and scalable Digital Ecosystems Impact Index

As mentioned in the previous section, socio-economic impact analysis is starting to gain visibility and recognition at international level. Particularly, there has been a big effort in recent years at European level to assess the impact of General Purpose Technologies (GPTs) on economic performance. GPTs, such as Information and Communication Technologies (ICTs), are *"radical new ideas or techniques that have the potential to have an important impact on many industries in an economy"* (CoE, 2006:10). In the Knowledge Economy, ICTs are seen as GPTs since they are used in multiple sectors and they enable bringing generalised productivity gains.

The interest surrounding the impact assessment of ICTs by European policy-makers is not a random choice. According to the European Commission (2005), a quarter of the EU's GDP growth and 40% of productivity growth in the Union are due to ICT. Additionally, globally, the ICT industry generates 8% of Europe's GDP and employs 6% of total workforce. Digital Ecosystems are said to address the issues of 'ICT adoption' and 'ICT development and service provision' (EC, 2008), and they are usually defined as the "*ICT-enabling technology for business ecosystems based on the dynamic and amorphous interaction among multiplicity of small organisations*" (EC, 2008). DEs are an ICT tool that fits with the characteristics of a GPT (based on CoE, 2006:10):

- Pervasiveness: DEs can be used and permeated by many industries and sectors,
- Technological dynamism: DEs have an inherent potential for realising technical improvements in those sectors and industries where they are used (process, service and product levels); and
- Innovation complementarities with other advancements: productivity generated in the industries and sectors of application (thanks to the DEs) entails an innovation and adaptation process in the DEs (productive and constructive innovation cycle).

Impact assessment studies usually try to track causality effects and relationships among variables, trying to derive from economic theory empirically testable hypotheses. Studies usually start at the micro-economic level; analysing the facilitators of ICT adoption, the value generating process from ICT, the impact of ICT use on firm performance, etc. Macro-economic studies follow the micro-economy; focusing mainly on ICT impact on productivity, particularly on total factor productivity (TFP)[21] through Growth Accounting. Economists have been trying to empirically found general and commonly popular propositions such as: ICTs contribute to productivity growth, ICT enables innovation, ICT usage matters for the competitiveness of firms, ICT is a major enabler of process efficiency, ICT has an impact on quality management and internal transparency, ICT increases competition, ICT use results in increased customer satisfaction with the offered products and services, etc. The results commonly derive in different conclusions.

Empirical efforts try to explain the causalities of variables in order to generate policy conclusions and implications concerning ICT-driven technological progress, and its macro-

[21] TFP is the part of productivity growth derived by intangible factors such as technical progress and organisational innovation rather than by capital inputs (EC, 2008b:3).

effects on the economy. The conclusions driven, among other uses, are useful to inform policy makers and guide them in taking decisions, through evidenced-based policy making.

The DEs research community has so far concluded on some propositions and implications related to DEs socio-economic impact, such as:

- *"A digital ecosystem can help break down the barriers in both, horizontal and vertical knowledge, since it entails a series of interconnected and intra-dependant digital platforms, that are created at key institutional levels (international, national and local/community), and augmented by technical (ICT) and social networking processes"* (Chatterjee et.al., 2007:178).
- *"This Open and Connected Platform (the DE) will lower the cost of entry and lessen technical barriers for SMEs, enabling them to realise the potential of on-line and connected business interoperability of SME applications, which in turn will pave the way for SME involvement in the knowledge economy and thereby increase their competitiveness. The enhanced cooperation between SMEs in a given sector, virtual cluster or even in a particular region, will also have the effect of increasing the trust, cooperation and knowledge sharing required to enable that knowledge economy to thrive"* (English et.al., 2007:184)
- *"The setting arising from the Digital Ecosystems (approach) has key opportunities for the internationalisation of EU SMEs, such as new market niches for products and services where SMEs can position themselves, utilising their comparative advantages in achieving flexibility, innovativeness, personalised contacts and quality of products. SMEs can secure their growth by participating in different DEs; and they can learn and innovate in fast track manner"* (Memedovic, 2007:9)
- *"On analyzing the economic impact of DBE implementation it is important to understand that different outputs can be expected according to the "weighted importance" that the concerned sector has on the regional economy"* (Rivera León, 2007:84).
- *"… the (DE and OPAALS research) findings will be transferable to the market only after several years and such endeavour will produce a tangible social and economic impact only in the long-term."* (Nachira et.al., 2007:2)

Task 11.5 focuses on the problem outlined above. How to create a multi-stakeholders policy framework, derived from empirical evidence on the impact of using and deploying DEs? Is there a model that can empirically found the impact-related conclusions theoretically derived by the DEs research community? Which policy conclusions and implications can we derive from the available evidence?

Towards an appropriate methodology for impact assessment of Digital Ecosystems

DE is not just about technology but rather about information transfer and communication through democratic processes embedded in socio-economic structures. The DE philosophy is non-techno-centric. Technology is only a tool that is used and adapted to socio-economic needs. This is why economic impact assessment is enlarged in Task 11.5 to socio-economic impact assessment, designed to assist a multi-stakeholder community in making decisions, surrounding DEs adoption and deployments that promote long-term sustainability.

5.3.1 The Digital Ecosystems Impact Index: main characteristics

The Digital Ecosystems Impact Index is an aggregated composite indicator, formed of four evaluation accounts: financial, user, economic development and social. It is an open and scalable tool for assessing the socio-economic impact of DE deployments at local/regional level. 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)[22].

Building the DEII has also two main methodological challenges:

1) The complexity of valuating tangible and intangible goods
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. 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). Cost-Benefit Analysis calls for 'Impact Statements' to explain qualitative effects and trade-offs that are impossible to measure or are subject to large errors while being measured (Campbell et.al., 2003:12). The DEII will integrate both, qualitative and quantitative information and data in an aggregated way. 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.

2) The tension between specificity and commonality

The second particularity of the DEII is that it aims to be an open tool that assesses and values general commonalities within specific settings. This 'tension' was already introduced in section 4.1: it cannot be argued that there is only a close-fixed framework/model to assess socio-economic impacts of DE deployments, but rather an open framework capable of identifying different impacts that are inherent to the socio-economic-policy framework of the region/territory of application. This means that the DEII will look at generalised common causalities, but not at specific (hard) generalised outcomes and conclusions. In fact, the DEII has to be sensitive to different local situations and needs. It has to be context-specific, since context will affect the 'shape' and the utility of the assessment tool. The above will end in a non-linear methodology that evolves within its policy formulation environment and readapts to, and with it.

5.3.2 Research Design and Methodology description

The global methodological framework: taking the best of Economic Impact Analysis and Cost-Benefit Analysis

At the outset of Task 11.5, two different assessment methodologies were studied: Economic-Impact Analysis and Cost-Benefit Analysis. Economic impact Analyses (EIA) indicate how projects affect directly and indirectly the demand for different goods and services in the economy. EIAs fail to consider opportunity costs (OCs). OCs can be defined as the cost of doing an activity (i.e. DEs deployment) instead of doing something else, or the next best alternative that is forgone whenever an economic decision is made (i.e. DEs deployment). EIAs consider all spending as having a positive impact, as they treat costs as benefits (the greater the costs, the greater the impacts). When accounting economic and social impacts as benefits, and ignoring opportunity costs, the study assumes that the economy is underutilised. EIAs do not provide an accurate measure of economic and social benefits (Shaffer et.al., 2003:7).

Cost-Benefit Analysis (CBA) 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

[22] The applications to the DEII of these three methodologies will be explained along the following sections.

efficiency of projects, programmes, policies and regulations (Munford et.al., 2000:79,80). Economic efficiency is at its core. Its aim is to address the question on what the net balance would be between economic 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, a multiple-account CBA global methodological approach will be used. It would be wrong to refer to the DEII as a pure CBA exercise, because this also entails some limitations (described below).

A Multiple-Account Evaluation

Multiple-Account CBA evaluation frameworks capture all of the factors considered in a socio-economic 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 deployment, are.

For the DEII, four evaluation accounts are being designed in order to provide an overall assessment related to DEs deployment:

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

Traditional Multiple-Account CBAs take into account also the effects on the environment through an Environmental Account. Nevertheless, in Digital Ecosystems research, sustainable development refers to "*the balancing effect that a greater level of integration of the social and cultural context with the economic life of a regions is assumed to have on its long-term economic viability"* (Nachira et.al., 2007:2,3). The definition does not contemplate environmental issues when referring to the concept of sustainable development. This is the reason why the DEII does not include an Environmental Account.

The rationale for the four evaluation accounts chosen for the DEII will be explained in more detail in following sections.

Limitations of building the DEII exclusively under CBA principles

It results extremely difficult to assign a *'Euro-value'* to all different impacts and to aggregate them into a measurement index of net benefits, as pure CBA evaluation does. This is especially the case when assessing socio-economic impact of deploying GPTs, such as DEs, whose philosophy deals with democratic mechanisms that aim to end in inclusive and constructing policy framework schemes. This is the reason why the four evaluation accounts of the DEII will be constructed using qualitative and quantitative data and information. The intangible assets valuation will be constructed by qualitative 'statements' such as Impact Statements based on CBAs methodologies, and Impact Analysis focusing on intangible assets (Allee, 2002:14) as per Value Network Analysis.

Additionally, the lack of any precedent on DE deployments apart from the pilot implementations in the regions of Aragon in Spain and the Midlands in the United Kingdom let us recognise the limitations of the first 'version' of the DEII. As it was outlined in section 4.1 the DEII will be stable only after continuous interaction with the policy world is enabled, as this will require testing and several iterations.

Another crucial remark about multiple account evaluations such as the DEII is that it does not intend to point out whether or not a project should be undertaken (i.e. deploying or not the DE). However, the DEII should be able to inform the policy choice and guide in decision-making.

From 'micro' to 'macro': Methodology description
The DEII will be built upon a bottom-up approach of DEs impact assessment, in its broadest sense. 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 behaviour, competitiveness and performance, all this mainly through the User/Consumer Account and Economic Development Account, built over surveys mainly on the pilot region of Aragon, Spain. From the macro-economic analysis, on the Economic Development Account, and to some extent in the Social Account, the policy impact will be derived. The micro-to-macro mechanism will allow driving policy conclusions and implications, and will favour the tracking of public policy challenges.

5.3.3 First Description of DEII's Evaluation Accounts

(Public/Private) Financial account: net return or cost to 'investors'

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

Two levels of financial costs are to be considered:

- Initial deployment costs: including the DEs infrastructure, Research and Development related to the infrastructure and its applications.
- Total Costs of Ownership (TCOs). TCOs comprise initial costs, setup costs, training and support costs. In the case of DE deployments, TCOs are training costs, research and training travel, events and conferences, human resources costs, infrastructure maintenance and SMEs service integration.

Two key terms are to be considered in the Financial Account (FA):

- The Net Present Value (NPV) of DEs deployments and the 'long-run principle'. When analysing the future stream of benefits and costs, the NPV of net benefits must be taken into account. NPV is central to traditional CBAs. NPVs express Euro values in different years in equivalent terms, recognising that 1 Euro spent today is more costly than a Euro that will be spent in one year's time. NPVs are calculated using a discount rate. The lower the discount rate, the greater the emphasis policy-makers give to long-term benefits (DEAT, 2004). The timing of the deployment will then have an effect on the FA.
- Opportunity costs of public/private funding for deployment. Analysing OCs is always important, because usually investment on ICTs, and specifically on DEs, is in competition with investment in other areas. This is true for any kind of financial source. In fact, one of the key objectives of the DEII is to give clearer information on the trade-offs produced by DE deployment to the entities financing the deployment; not only related to the return on investment on tangible goods and assets, but also on the return produced by intangibles.

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.

User/Consumer account: net benefit to users as 'consumers' of what the DE provides

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 DEs deployments. The first line of research questions to be answered is, who are the DE users? Are the DE users the same as the DEII users? Are they different? What is the value that DE users give to DE deployments?

The central economic question for the account is the analysis of the value that DE users place on the net benefits produced by DEs deployments. Which *willingness-to-pay* (WTP) do DE users place on DEs deployment? In economic terms, WTP is the maximum amount of money that may be contributed by an individual/user to equalise a utility change. The given monetary value is an indicator of the value to the user of the referred commodity. The User Account will look at the WTP of DEs deployments. Valuating WTP is relatively easy for market-goods and tangible goods and assets. It is more difficult for the case of non-market goods and intangible goods and assets. Positive and negative impacts are expected to be different for each 'user'. Costs and benefits of all value-generating activities will be calculated in terms of tangible and intangible net benefits and/or costs. In the case of impossibility of obtaining quantifiable net benefits, a qualitative valuation exercise will be pursued.

The account will consider all the groups internally and externally that play key roles in DEs deployments. Three groups of DE users have been identified so far:

- Business Users. Mainly composed by the business sector, notably SMEs (differentiating by cluster typologies), including the communities of SW developers. For this group, the DE impact is related to the process of organisational change and the capacity of innovation enabled by DEs.
- Knowledge Users. Mainly universities, researchers and Knowledge creation and dissemination enablers. For these, DEs are an enabler of knowledge exchange and knowledge creation.
- Strategic Users. Notably public bodies (national, regional and local administrations), policy-makers and decision-makers. For this group, DEs deployments are seen as a new approach for sustainable development, or as a local/regional development strategy.

It will be possible to derive a differentiated and independent DEII by each DE user. This will be possibly of special interest when the DE deployment is financed directly by a business cluster, or through a PPP. In this case, the cluster might be interested in looking at the independent trade-offs for the user of interest. Nevertheless, the account can also indicate global trade-offs for all of the identified DE users if the DE deployment is financed through regional partnerships, or directly by regional policy-makers, decision-makers or by the local/regional government.

The next research step is the definition of the key indicators per user type, and the possible identification of new user groups.

Economic Development Account

The EDA will be the most theoretical account of all four. The Account will separate the analysis between microeconomic and macroeconomic impacts, assuming that macro-economic impacts will come after the micro impacts expand throughout a region or territory. In the first version of the EDA, the DEII will just trace qualitative indications of the expected impacts produced. The reason for this is that evidence of DE deployments is for now at a pilot level, while impacts on microeconomic and macroeconomic variables are expected only on the long-term (Nachira et.al., 2007:2). For now, it is impossible to derive hard conclusions. The qualitative indications to be given in the EDA on the expected net benefits will be mainly based on economic theory, as per the outlines, rationale and framework of section 4.2.

It is important to underline that in 'future' versions of the DEII, the EDA should be looking at incremental effects and impacts produced by DE deployments: estimate micro and macro-economic impacts that would not otherwise be realised at the regional/local level without the DE. The process of analysing incremental effects is inherently an uncertain process because it is dependent not only on the success (or not) of the DE deployment, but also on what would or could have occurred without it.

There are three key questions to be answered under the EDA. First, which are the expected micro-economic impacts, mainly related to organisational change, produced by DE deployments? Second, which expected impacts would be produced at macro-economic level, on variables such as productivity, growth and employment? Finally, and more important for CBAs, what is the significance of these impacts – what net benefits do they provide at the regional/local levels?

Microeconomic impacts and effects

DEs applications are characterised by their diversity, because of their 'general-purpose' characteristics described at the beginning of this section. This raises the probability that they can impact the nature of work at the micro level, through microeconomic processes, magnifying their economic and social impacts. Tangible and intangible impacts are expected in the process.

The first, and probably most important source of change, originates from the transactional impact of DEs, through their effect on transparency and power. The core of the economic impact of DEs springs from their capacity to process and disseminate information among DEs' users. These features are expected to facilitate transactions and specifically improve transparency. In economics, transparency is the determining factor for how efficiently market players realise transactions that maximise their value or utility; or minimise the costs associated to such transactions. Through the DE, the transaction mechanisms seem destined to change, because of the critical capacity of DEs to 'automate' the steps involved in a transaction (i.e. search, matching, execution and delivery). In the case of a Digital Business Ecosystem (DBE), the first-order effect of the above would be the increase on the number of market players (buyers and suppliers), thereby enhancing competition. Since every business interaction in a DBE would involve transaction costs, each DE user would represent a potential source of value added if costs can be reduced. Additionally, since business units remain independent, firms would not sacrifice their comparative advantages, enabling then a 'competition-collaboration' business relationship.

Other expected impacts to be further studied in T11.5 are those related to reorganisation and productivity. It seems reasonable to expect the pervasiveness of DEs to affect economic efficiency, through two main properties accounting for this (based on EC, 2001:237):

- Information handling in DEs. It would be more efficient through the availability of an information pool across the value network.
- Resource allocation in DEs. It would be improved by the information exchange among DEs users regarding the value creation processes in the value network.

At the firm level, DEs impact should be felt on the supply and demand sides of the firm. On the supply side, DBE applications can make achieve greater flexibility on internal operations of the firm. On the demand side, DBE can help firms to improve product and process quality, product and service variety, timeliness ('time-to-market' performance) and customer service/customer relationship management.

Nevertheless, as DEs rely on interconnectivity, their impact depends highly on uptake. The benefits from the DE outlined above are a function of the number of users. Reaching a critical mass of users is a prerequisite for 'accessing' to its benefits.

Additionally, out-weighted to the possible expected benefits, adjustment costs of DEs users need to be evaluated in order to make an accurate analysis of DEs deployment net benefits.

The EDA will communicate with the FA, regarding the TCOs to be analysed in the latter. New organisational changes seem necessary for taking advantage of the full benefits of the DEs (as is the case for general ICTs). The adjustment process might be costly to users, all depending on their context-specific configurations and characteristics. Also, DE users must be motivated to actively engage in using the DE before it is possible to achieve efficiency gains. This is why it is important that the DE is a 'user-friendly' tool, useful and adaptable to the necessities of its users.

Macroeconomic impacts and effects

The analysis of macroeconomic impacts in the EDA will be theoretical in its totality. The sub-section will present theoretical insights and discussions of mainly three variables affecting regional economic development: productivity gains; growth and output; and employment effects. The macro-economic impacts and effects produced by DEs deployments will be only integrated empirically in the DEII in the long run, once a critical mass of users and platform stability and use is achieved in a given DE.

The available evidence at the macroeconomic level suggests that rapid development of ICTs would have a significant positive effect on macroeconomic variables, such as productivity growth and output (see for example: EC, 2001b). Nevertheless, the magnitude of the impact is still subject to controversy. Macroeconomic 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 macroeconomic potential of ICTs.

This exemplifies the difficulties in the measurement of macroeconomic impacts of DEs, mainly because it is commonly argued that technological progress enabled by GPTs, such as the DEs, usually take several decades for the wider benefits (on the macro-economy) to emerge (see IMF, 2001).

Output and Productivity Growth

The European Commission (2001b:40) identified three separable channels through which ICTs affect output and productivity growth: technological progress in the production of ICT goods (direct effects on the ICT sector spreading to the economy depending on the weight the ICT sector accounts for); Capital deepening in the total economy (indirect effects produced by increases in the productivity of labour); and Spillover effects (impacts generated by production spillovers or externalities). In the case of the DEs, complexity of the analysis rises since, additional to the three proposed channels, impact has also to be valued for two sectors of reference: the local/regional software industry (1); and the local/regional sector or industry of relevance (the sector chosen for DE deployment)(2).

Employment and Impacts in the Labour Market

The European Commission (2001:243) has argued that investments in work reorganisation or human capital might be a necessary condition for achieving the potential productivity effects of ICTs outlined in the above sub-section. Organisational changes and adaptations required by GPTs are impacted by the characteristics and level of flexibility of the labour markets and the availability of human capital capable of adapting to the changes enabled by DEs. This section will analyse theoretical insights on what the potential impact of DEs is on overall employment and unemployment; analysing also framework conditions such as labour market flexibility, and the importance of human capital and training. It is expected that this sub-section communicate with the sub-section studying the micro-economic effects and impacts of DEs; and with the FA through the importance of the TCOs.

The EDA holds probably the most 'ambitious' research agenda for the following months. It is a particularly challenging exercise. The account will be strongly linked to the second layer/stage process in T11.5: the creation of a Multi-stakeholders policy framework for DEs.

Social Account: Community and social impacts

The Social Account (SA) will look at social and community impacts produced by DE deployments, linking them to the opportunities or benefits acquired by DE users from these deployments. Higher net benefits in the SA will appear when negative social and community impacts are minimised, while opportunities and value-gains are maximised by DE users. The SA will illustrate how DE deployments make a difference in its users well being and in that of the territory of deployment. In combination with the other Accounts, the FA will help in the assessment of the social aspects related to DEs deployments.

In the world of economics, social factors have been increasingly recognised as central to the competitive challenges of the knowledge-based economy (Steinmueller, 2004:4). The density and structure of social networks is crucial for acquiring democratic organisation in a society. The concept of 'social capital' will be thus central in the SA. Following Steinmueller lines (2004:4), 'social capital' in the FA will consider formal organisations in the society and social networks, including 'communities of practice' (Bourdieu, 1997, Granovetter, 2007, Polany, 1944 and 1974, Sahlins,1976) .

A preliminary list of variables to be analysed in the SA is presented below. The list is not final, and subject to modifications and additions in the next months.

Social inclusion, participation and quality of life

Social inclusion and participation are central concepts in any public policy strategy that promotes economic development. When a fraction of the social structure is under-represented or not represented at all, democratic processes are triggered. DEs are to help in fostering participation and inclusion because the network infrastructure is distributed and the interactions are operational rather than hierarchical.

Access to information and effects on lowering power and information asymmetries in the socio-economic structure

Inequalities in accessing information create further inequalities in participation/participative processes. The possibility of being connected in a DE, and to share and acquire knowledge, is a contributor to reduce the information gaps and to lower power asymmetries (Rivera León, 2007:83) between actors/DE users.

Impact on social capital.

Social capital, that in accordance with Bourdieu, is defined as "the sum of resources, actual and virtual, that accrue to an individual or a group by virtue of possessing a durable network [...] of mutual acquaintance and recognition" (Bourdieu, 980:22) prove to be an important element in territorial innovation. The possibility to participate at the DE implementation and usage can reinforce already existing social networks and, at the same time, foster the creation of new links, or a more horizontal organisation of them.

Impact on territory image

As the DE expands in a given territory, and thus provides access to information, inclusion and participation among its users; the image of the given territory is likely to be changed (in a positive or in a negative way) among the persons and organisations internal to the territory, and to external entities. Characteristics such as trust capital for policy-makers in the territory, the capability of attracting new investments, and the ability to interconnect and collaborate with other territories will be factors of analysis.

Impact of knowledge sharing

Steinmueller (2004:2) underlines that a central assumption of literature on the knowledge-based economy (i.e. by Romer, 1986) identify the relevance of knowledge as a provider of new possibilities for improving productivity in different spheres of economic activity. He

signals that the generation and use of knowledge involves fixed costs that can be amortised by distributing, re-using and sharing knowledge, within organisations and persons or between them. Social capabilities, as well as other factors such as investment and institutional reform, are determinant in enabling knowledge sharing.

The SA will communicate closely with the Multi-stakeholders policy framework to be developed in the second layer of T11.5; particularly in topics related to the impact on economic performance of variables such as participation and social relations towards sustainable economic growth. Perhaps the most valuable input of the SA to the referred policy framework will be the support of a better understanding on how social challenges are determinant in achieving economic results and progress through DEs.

Some preliminary Conclusions

There are extremely big difficulties and challenges emerging for these difficulties in assessing the socio-economic impact of Digital Ecosystems deployments. One of the main sources for this is the unavailability of data and the absence of strong cases of deployment. The most likely consequence of this will be that the analysis provided by the DEII will generate rather general conclusions and might fail in becoming a hard and stable framework for policy analysis. Additionally, because of the available sample of DE users is yet limited, the conclusions might not be representative of the sector/region of analysis, and these would be those of a case study rather than a source for developing a stable framework.

In order to overpass this risk, we will focus most of out attention in developing a sensitive, open and flexible methodlogy that different policy makers and stakeholders can then use in different time-frames.

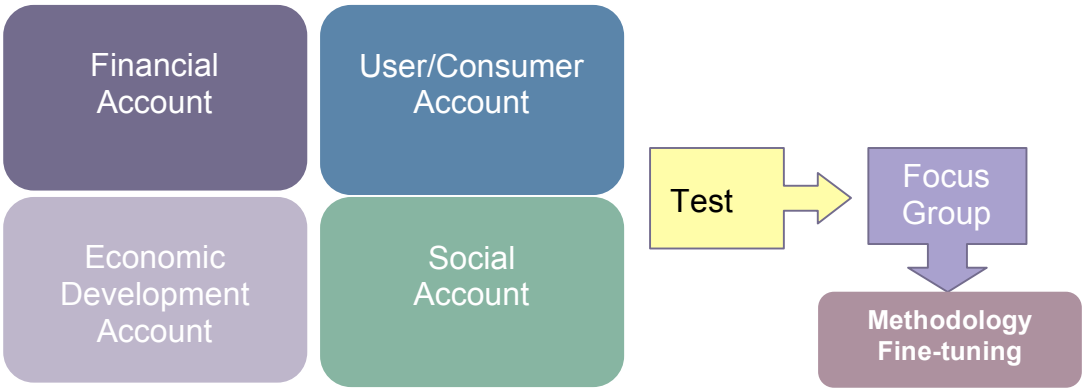
Moreover, policies cannot be generalised: different policies are needed on the level of DE usage per user group and per sector of applicability. It is thus impossible to conclude on general policies per sector, country or region, mainly because of technological determinism and context-specificity. Framework conditions are also essential in promoting a favourable environment for innovation through Digital Ecosystems. The researcher must have all of this in mind when using the DEII for driving policy conclusions.

Despite the limitations, the DEII will provide in all cases an analysis on different variables and mechanisms theoretically enabled by DEs deployments that has no precedence in Digital Ecosystems research.

5.4 The process of DEII design and validation

So far the main components of the DEII have been described. In the following research months the variables described above will be better defined. Regarding data, a map with the already available data sources will be developed; and a selection of methodologies needed in order to gather extra-data will be operationalised. As mentioned before, the methodology to be developed has to be *open,* in order to be used directly by local stakeholders; and *scalable,* in order to be adaptable to different territorial settings. The following process of DEII test and validation is proposed in order to assure the above two characteristics (Figure 5.1).

Figure 5.1 – The process of DEII validation



As a first step (1) each account (financial, user, development and social) will be associated to its variables and a set of data sources. In this process, European and International Organisations' data sources will be privileged in order to allow comparability between different territories. Additionally, national and regional data sources will be also explored. Due to the difficulties on data availability for some variables (especially in the case of the Social Account), different methodologies delineated by local stakeholders will be used in order to gather extra data (2). An accurate guide on the use of the methodology to the users will be developed. As a third step (3) a synthetic index for each account will be developed. This process needs to be fully transparent to the users, in order to work with different variables. This is also important in the case of no data availability (or no representative data) regarding one or more variables. As a fourth step, the DEII will be tested (4) in a specific territory. For now, the most probable test area is the Aragon region that has been involved in the DBE project and, in that context, already selected and engaged some users. The test phase is going to be risky due to the fact that there is no concrete community of users for now, neither a territory that has fully deployed the DE. Nevertheless, as research activities for task 11.5 continue till month 36 (M36), it is expected that any region involved in the DEN4DEK[23] project, will be able, by then, to make progress on the DE implementation.

After the test phase local stakeholders will be actively involved (5) in order to disclose them the methodology and the first test results. The DEII first release will be validated with them taking in consideration their suggestions and comments. The methodology will be fine-tuned and a final version will be released. The following stakeholders will be most likely involved in the test:

- Local and regional policy makers of the territories already experimenting the DE;
- Local and regional policy makers of those territories that show interest for the DE approach (mainly those involved in the DEN4DEK project);
- Scientists (social science and economics) actively working in the territories mentioned above;
- Representatives of SMEs and SMEs' clusters;
- Other interested researchers or experts in socio-economic impact methodologies.

A focus group methodology will be used in order to involve stakeholders allowing the access not only to the opinions of single stakeholders but also to the differences in approaches and necessities of different territories. The focus group methodology is a qualitative methodology

[23] DEN4DEk (http://www.den4dek.org) is a thematic network, funded by the European Commission, aiming at sharing the knowledge of the Digital Business Ecosystems (DE) and promoting innovative actions that facilitate the up-take of the DE approach at European level.

that allows the collection of opinions of different actors at the same time. Questions are asked in an interactive group setting where participants are free to talk with other group members. By using this methodology, an open debate will be fostered: not only about the DEII, but more widely about the DE approach and about the usage of research methods in policy definition and application. By bringing together stakeholders representing regions already aware of DEs with less experienced ones, an occasion to exchange opinions and doubts about the possible impact of DE implementation to their territory will be offered. The focus group will represent also a possibility to support the exchange between researchers and policy makers and start a necessary dialog that will bring to the definition of policy recommendations and roadmaps.

It is expected that after the first methodology fine-tuning the DEII will be able to provide its first conclusions and communications with the policy-world. Nevertheless, as it has been continuously outlined along this Report, several iterations/fine-tunings will be needed before arriving to a 'stable' version of the DEII. Although this dynamic dialogue and co-operation with the policy world is out of the scope of this task, the outline and framework that enables this dialogue will be encouraged within the third methodological step.

5.5 DEII and 'evidence-based' policy-making

Data are simply a resource that requires to be processed before becoming an input into policy analysis (Bartzokas et. al., 2000:25). This is the fundamental reason why Task 11.5 is divided in two complementary layers of discussion. The first layer, the DEII, will be dealing with the production of evidence, thus serving as a decision support system. The second layer, the synthetic policy framework to be used by policy-makers and regional stakeholders interested in the deployment of the DE, will be the outcome of dynamic interaction with the first layer (process). Both layers are not independent and they will influence each other. Nevertheless, it is out of the scope of the task to integrate multiple interactions with the policy world. A focus group is contemplated to fine-tune the methodology, but this process will conclude in a 'first round' of interaction that does not has to be taken as a finite process. The second layer will vary inexorably from region to region, as argued above.

One has to be careful when drawing conclusions coming from the DEII. It would be wrong to suppose that the DEII will be an integrated "ready to be applied" package of evidence (or guidelines) that can be treated as an independent basis for policy. Going from evidence to policy does not follow a linear model, or a unidirectional relationship as suggested by the term 'evidence-based' (Rip, 2000:97). DEs are not context-independent. The DEII will become more effective when it becomes an open process, an evolving network, of interdisciplinary relationships that include policy-makers.

Some preliminary conclusions

The DEII is to be seen as the first step for enabling interaction between the OPAALS and the policy-making world by regional stakeholders. It will end in a multi-stakeholders framework that could be seen as the hints for 'distributed intelligence', because all the relevant information and knowledge that will comprise the DEII are distributed across regions, actors and settings. The DEII will conclude in an integrated assessment model, whose outcomes must be internalised as a part of a particular structure (social, economic, politic and institutional) that will differ from user to user, as its policy use and usefulness will be context dependent.

There are extremely big difficulties and challenges emerging for these difficulties in assessing the socio-economic impact of Digital Ecosystems deployments. One of the main sources for this is the unavailability of data and the absence of strong cases of deployment. The most likely consequence of this will be that the analysis provided by the DEII will generate rather general conclusions and might fail in becoming a hard and stable framework for policy analysis. Additionally, because of the available sample of DE users is yet limited,

the conclusions might not be representative of the sector/region of analysis, and these would be those of a case study rather than a source for developing a stable framework.

Moreover, policies cannot be generalised: different policies are needed on the level of DE usage per user group and per sector of applicability. It is thus impossible to conclude on general policies per sector, country or region, mainly because of technological determinism and context-specificity. Framework conditions are also essential in promoting a favourable environment for innovation through Digital Ecosystems. The researcher must have all of this in mind when using the DEII for driving policy conclusions.

Despite the limitations, the DEII will provide in all cases an analysis on different variables and mechanisms theoretically enabled by DEs deployments that has no precedence in Digital Ecosystems research.

Conclusions

The general objective of WP11 is to develop a methodology that can bridge the necessarily theoretical deliberations surrounding the emerging concept of Digital Ecosystems with the necessarily practical concerns of regional development policy, in the context of the Knowledge Economy, through the capitalisation of research findings in order to generate practical policy learning that is meaningful and workable at the regional scale.

Four intermediate objectives were identified. Firstly, T11.1 focuses on the social and spatial structures of collaboration and knowledge flow that underpin innovation among SMEs, through two sectoral case studies in the (Modern) biotechnology and digital media industry in Ireland. The objective is oriented towards the identification of the potential role that DEs have in the innovation processes of SMEs. Secondly, T11.2 looks at how to engender confidence among innovators in sharing knowledge to compensate for their relinquishing of IPR claims, analysing the role of institutions and IPR schemes in supporting knowledge sharing, clarifying the kind and the degree of IPRs that is used by firms through a case study in two sectors in the Greater Cambridge area. The objective is to discover whether the European IPR system as it stands inherently fails the firms and if there are alternatives to patents for stimulating innovation in SMEs. Thirdly, T11.3 and T11.4 study the question on how to accelerate the knowledge-driven growth model process of collective learning and the knowledge creation processes in agricultural economies. The studies first look at the structures of communication and collaboration among actors in the Indian agricultural domain. The focus is on analysing the ongoing processes of network building (theoretically and empirically) with the objective of creating a typology of network structures among 'knowledge-actors' in the Indian rural domain, so as to identify a suitable 'soft' architecture for creating a DE in that context. The studies then look at how the OPAALS framework could be applied as a social innovation network, by developing an ethnographic study of the stakeholders engaged in the Agropedia project of NAIP, looking at how different models manage the dialectical tensions of a large, participative, and innovation network. Finally, T11.5 will develop a methodology that is able to assess through a quantitative and qualitative analysis the socio-economic impact of DE deployment at local/regional levels that will end up in the Digital Ecosystems Impact Index (DEII). The DEII will further help to develop a multi-stakeholder policy framework for regional economic development that will also integrate the conclusions coming from the case studies developed in T11.1 to T11.4 and translate them into policy conclusions.

The following Table summarises the research agendas to be developed in the following months within WP11.

Task No.	Task Name	Research Design/Methodology	Case-studies/sectors and/or applications
T11.1	Social and spatial structures of collaboration and innovation in the Knowledge Economy	Multiple case-study design as defined by Yin (1993, 2003): concerned with context (multiple sources of evidence that can be quantitative or qualitative). Case studies take the form of "innovation biographies" Data collection method: semi-structred face-to-face interviews and	Modern Biotechnology and Digital Media sectors in Ireland

		search of public sources	
T11.2	The role of institutions and IPR schemes in supporting intentional and unintentional knowledge sharing	Grounded Theory Method for Qualitative Analysis	Peterborough environmental industry and the Greater Cambridge knowledge-based cluster
T11.3	The knowledge creation process: structures of communication and collaboration among Actors in Indian agriculture	Grounded Theory Approach	Observations taken from the knowledge management project under NAIP, coupled with frameworks and conceptual variables extracted from literature
T11.4	The Dialectics of an innovation network applying the OPAALS framework in the context of Development	Dialectical inquiry as a method of socio-technical research (derived from the work of Chruchuman, 1971)	Longitudinal ethnographic studies of two parallel models for knowledge acquisition, storage, value addition and dissemination in Agropedia (classical “paid-for” model and “co-creative and contributory” model); in terms of output, outcome and impacts
T11.5	Multi-stakeholder policy framework for regional economic development through Digital Ecosystems	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).	To be defined

The general progress of the first six months of research activities was to delineate the research agenda and research plan through the description of goals, methodologies, challenges and theoretical frameworks, with the specific objective of finding research synergies and channels of collaboration among WP partners and all project partners. Common research ground has already been identified, and the integration to the OPAALS community of new partners has been successful.

The following paragraphs summarise the main research activities progessed by each partner and per research Task.

Task 11.1 - NUIM

Partner NUIM has been working in the definition of the Theoretical Framework and research design that will guide T11.1. The premise of the research is that there are varying pathways to successful innovation and that the socio-spatial structures underlying these pathways vary by industrial sector. NUIM has focused on the influence of a selected number of

differentiating factors, such as type of knowledge; central occupational group and knowledge communities; and organisation of firms and markets. The research design for the Task has also been defined (case-study design as defined by Yin-1993, 2003), covering the logic of design, data collection techniques and specific approaches to data analysis. NUIM has also developed a brief description of the characteristics of the (Modern) biotechnology and digital media industry in Ireland, as a rational for the case study selection. Finally, NUIM has been working on the development of a preliminary version of the interview guide to be used in the study.

Task 11.2 - CAM

CAM has worked in the preparation of a literature review on the merits of IPRs, specifically patents, and alternative valuations and approaches to knowledge captured in useful inventions. CAM has also prepared the Field Work scheme for an inquiry into how IPRs are being used in the Peterborough Environmental Industries and the Greater Cambridge Knowledge-based Cluster, including profiles and backgrounds of the industries with comparisons and contrasts. The methodology approach (non-positivist) chosen for the Task is the Grounded Theory Method (GTM) for qualitative analysis. CAM has started to analyse the candidacy of DE for embedment in such configuration of firms and their support structures.

Task 11.3 - IITK

Partner IITK has worked in the definition of a research plan for the Task, including goals and challenges. It has initiated its Literature Review and Synthesis, mainly on topics regarding the evolution of social systems as ´legal personalities, social relationships, social capital and communication structures networks, ICT and communication environments, and the evolution of Knowledge Management Systems. The Methodological approach chosen for the research is based upon Grounded Theory, which is dependent upon its process of generation and seems to be suitable to accommodate the action research procedure where the researcher is part of the system under consideration. Finally, IITK identified its expected outcomes of the research effort, along the lines of developing theoretical insights on knowledge creation and sharing, the depiction of social capital pattern, typologies of network structures. The next step will be to develop a methodology to compare the quality appropriateness of the commissioned and contributed content.

Task 11.4 - IITK

IITK has worked in the definition of the research methodology for the Task. The research agenda of the Task will be driven to the deliverable of 3 research papers in M36, focusing on: developing the theoretical framework for anthropological understanding of the socio-digital space; the role of social informatics and social media in organising large scale social innovation; and the effect of intrinsic and extrinsic rewards on knowledge sharing behaviour in a digital ecosystem. The chosen approach for research is the dialectical inquiry as a method of socio-technical research derived from the work of Churchman (1971) on “The design of inquiring systems”. The approach is a qualitative research method, focusing on the content and meaning of models and theories in use. This process should help developing deeper insights into the ongoing debate about true effectiveness of digital tools in the social development context. The analysis will be conducted through an enhanced Soft Systems Methodology (Checkland, 1990) developed at IIT Delhi (Sushil, 2000; Sushil and Chatterjee, 1999) called SAP-LAP.

Task 11.5 – T6 ECO

T6 ECO has been working in the definition of a research agenda for an open and scalable Digital Ecosystems Impact Index (DEII), including the search for an appropriate methodology for impact assessment of Digital Ecosystems. Building the DEII will require a combination of 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). Building the DEII has also two main methodological challenges: the complexity of valuating tangible and intangible goods, and the tension between specificity and commonality in DEs impact assessment. T6 ECO has developed a first and preliminary description of DEII's evaluation accounts. It has deepened the rationale for studying the socio-economic impact of DEs, regarding the conciliation of the concept of impact with the ecosystems/ecosystemic approach.

A future research agenda: towards a Digital Ecosystems-use Value Chain

The research agendas introduced and developed in this Deliverable constitute the axis for a compatible and integrated research goal. Common research interests and methodological choices are already visible in this Deliverable. There is the belief among the WP11 partners that, by M36, it would be possible to strategically integrate WP11 research outputs into an overall concept: the Digital Ecosystems-use Value Chain.

The DE-use Value Chain would possibly integrate three 'DE-use' steps that generate value, ending in performance by DEs users surronding the concepts of knowledge creation, use and dissemination for development:

1. DE adoption. The first DE-use step consists in promoting the adoption of DEs by (final) users. This step is indeed dealt by generally all WPs in OPAALS. Nevertheless, in the process of 'persuation' for enabling DE adoption, policy-makers are a key stakeholder for the achievement of the objective. The DEII would play a central role in this process. This first 'use' step would be then dealt (to some extent) by T11.5.
2. Innovation enabled by Digital Ecosystems. The second DE-use step consists on innovation enabled by knowledge creation, use and dissemination enabled by Digital Ecosystems. Most of the Tasks in WP11 are involved in this step: from knowledge creation (T11.3 and T11.4) to innovation enabled by organisational change in SMEs through the structures of knowledge sharing and communication in DEs (T11.1). Additionally, as a peripherial but crucial step, T11.2 deals with the enablers of innovation: the role of institutions and IPR schemes in supporting knowledge sharing.
3. Performance. Finally, the third step in the DE-use Value Chain is performance enabled by Digital Ecosystems. Some of the case studies to be developed in WP11 aim to show the effects of DE use and deployment in performance on DE-like environments. Although some initial aspects on the performance effects of Digital Ecosystems might be shown at the end of WP11, further iterations with the policy world will enable a more coordinated exercise of evidence-production of DEs use on performance by its users. WP11 is just an initial step towards the final objective.

Arriving to this final research step, that of the definition of a Digital Ecosystems-use Value Chain, is a rather narrative-mechanicist research approach that will need to be further explored by WP11 partners. The metaphor of a DEs-use Value Chain could be especially useful in organising the policy recommendations that each WP Task will produce as a research output in M36 (as per the general objective of the WP). Each DE-use step of the chain would involve value generation processes that could provide a series of recommendations at the policy level. These would be relevant for T6 ECO's work in the process of delineating a policy Road Map for DE implementation.

For now, the DE-use Value Chain remains as a latent proposal, under construction, that might be further explored and used, or not. The choice remains discretional and dependent on the development of the overall research development of the WP. The following research months will be particularly crucial for finding consensus among partners. This is especially necessary for not excluding any thoughts and research findings of relevant social science researchers involved in the OPAALS.

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