Digital Cities and the network society: Towards a Knowledge-Based View of the Territory?

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Paper prepared for publication in "Learning and Knowledge for the Network Society",
D. Gibson, M. Heitor and A. Ibarra (eds), Purdue University Press

September 2003

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The development of case studies in selected Portuguese cities and regions which have been engaged in "digital city" projects is considered in this paper in a way to discuss main challenges, and opportunities, for mobilizing the information society in Europe, with emphasis for the conditions affecting less favourable zones. It is argued that value-based networks have the potential to make both public administration and markets more effective, which helps promoting learning trajectories for the inclusive development of society, but require effective infrastructures, incentives and adequate institutional frameworks. The analysis builds on the concept of social capital, as a relational infrastructure for collective action, but the main contribution of the paper is presented in terms of a *knowledge-based view of the territory* to foster institutionally organized metropolitan *systems of innovation and competence building*.

Competence building is considered in terms of a dynamic and broad social and economic context associated with digital networks and the analysis suggest the need for continuous public support and monitoring, as well as for the promotion of knowledge integrated communities as drivers of larger communities of users.

1. Introduction

In view of the current socio-economic context, in which innovation is a key driving force for the sustainable development, which challenges are facing information-based development and cooperation, in a way to contribute for regional policies that stimulate localized learning and indigenous development within less favoured regions in Europe?

This broad question has motivated the work behind the present paper, which considers the development of case studies in selected Portuguese cities and regions, which have been engaged in building digital networks. It is argued that value-based networks have the potential to make both public administration and markets more effective, which helps promoting learning trajectories for the inclusive development of society, but require effective infrastructures, incentives and adequate institutional frameworks promoted over time and across space [1]. Early-stage developments are shown to be particularly dependent on public funding and the necessary institutional framework, including the development of knowledge-integrated communities. The analysis builds on the need to continually adapt trajectories and foster the necessary learning capacity of increasingly diversified communities, which refers to social capital as a relational infrastructure for collective action [2], in a context much influenced by a dynamic of change and a necessary balance between the creation and diffusion of knowledge.

In this context, the main contribution of the paper is presented in terms of a *knowledge-based view of the territory* to foster institutionally organized metropolitan *systems of innovation* [3] *and competence building* [2], which derives from observations in different Portuguese metropolitan areas with the ultimate goal of increasing regional competitiveness, by promoting public awareness and participation in decision-making processes. It is argued that

the territory is a basic infrastructure that justifies and invites for the construction of several layers of information about cities and regions were people live, visit or do business. Digital city schemes should also encourage the global legibility of the information architecture of the territory and promote broad and informed participation in the decision-making process of the future of its entire influence area and not only within city limits [4].

Although we are still in a very early and limited stage of what Mitchell [5] called 'cities of bits', it is clear that it has become a "commonplace" to discuss the diffusion of knowledge, and the "knowledge-driven economy" in general, in close association with the introduction and use of information and communication technologies [6,7]. In this context, several national initiatives for the Information Society aim to achieve four broad objectives: to create a more open state, to link and make available to all the available knowledge, to promote Internet usage in education, and to support and develop digital technologies usage by firms [8]. The evidence calls for our attention for the critical role of public funding and the dynamic adaptation and development of the context necessary to facilitate digital cities.

The work follows current discussion in Europe aiming to: (a) ensure widespread broadband access and a secure information infrastructure; and (b) services, applications and content, covering online public services and e-business [9], but argues for the need to plan systematic actions of competence building with the ultimate goal of attracting new communities of users and to build the necessary capacity for connectivity. Community building and demand creation for digital services became the critical factor for implementing digital cities, requiring proper incentives and institutional settings.

The remainder of this paper attempts to frame these aspects from the perspective of the challenges facing *digital cities* in Portugal. We begin by bringing empirical evidence on the Portuguese situation, as a specific case study within EU. Clearly, Portugal has significant quantitative shortcomings, but, at the same time, the country has been making good progress, in a catching-up dynamics that is well known. This combination of rapid catch up but persistent shortcomings make the Portuguese case useful to illustrate the main point of the paper: network societies occur across time and space and require the dynamic adaptation of infrastructures, incentives and institutions, in a way that calls our attention for the need to foster learning societies. The third section, informed by the empirical evidence associated with the analysis of the Portuguese situation, discusses current evidence from specific case studies, based on specific digital city projects. The need to consider the context of social interactions and institutions that govern the behaviour of individuals and organizations is analysed in section 4. Thus, we discuss the necessary conditions for the establishment of knowledge driven activities and present a conceptual framework for understanding digital cities based on a knowledge view of the territory. Finally, we conclude by briefly presenting policy implications and a summary of our most important conclusions.

2. Building the network society across diversity: Portugal in Europe

Focusing our attention to information and communication technologies (ICT), Figure 1 presents the intensity of ICT expenditure in 1997 against the growth rate of this intensity from 1992 to 1997. Following recent analysis for knowledge-based industries [10], the results show that Portugal was the leading OECD country in the growth rate of ICT expenditure from 1992 to 1997, with a growth rate of more than 10%, and mainly accounted for by increases in expenditures in telecommunications (about 9%). Expenditures in IT services and software are particularly low, below 1%, and only Turkey, Greece and Poland have shares of expenditure

on IT software and services below the Portuguese value. The growth in this category has been equally dismal, below 2% a year.

In terms of our analysis, we would like to argue that the figure shows large variations associated with countries characterized by small absolute values, exhibiting patterns typical of latecomer industrialization for Portugal. In addition, the results may represent indications of the process through which latecomer countries become engaged in the new techno economic paradigm [11]. Most countries are clustered in the bottom of the figure, with growth rates below 4%. The levels, as indicated by the horizontal distribution of countries, confirm the perception that the US is a leading country. The expenditures on ICT as a percentage of GDP in the US are about 2% above the European average. Individual countries, such as Sweden, outperform the US, but most countries lag behind.

The evidence of still low absolute investments on ICT in Portugal is clearly illustrated in Table 1, which shows values per capita for sample European regions in the census whose programming documents indicate information society actions and that provide the necessary financial information [8]. It is clear that the table refers, above all, to regions that have attracted European structural funds and, on this basis, it is important to mention the wide diversity of situations and framework conditions for attracting these funds, which clearly influence any analysis to be considered. But for the purposes of our analysis, it is interesting to attempt defining the extent to which the performance of digital networks and cities would depend exclusively on the limitations of funds, as well as from the capacity to attract them.

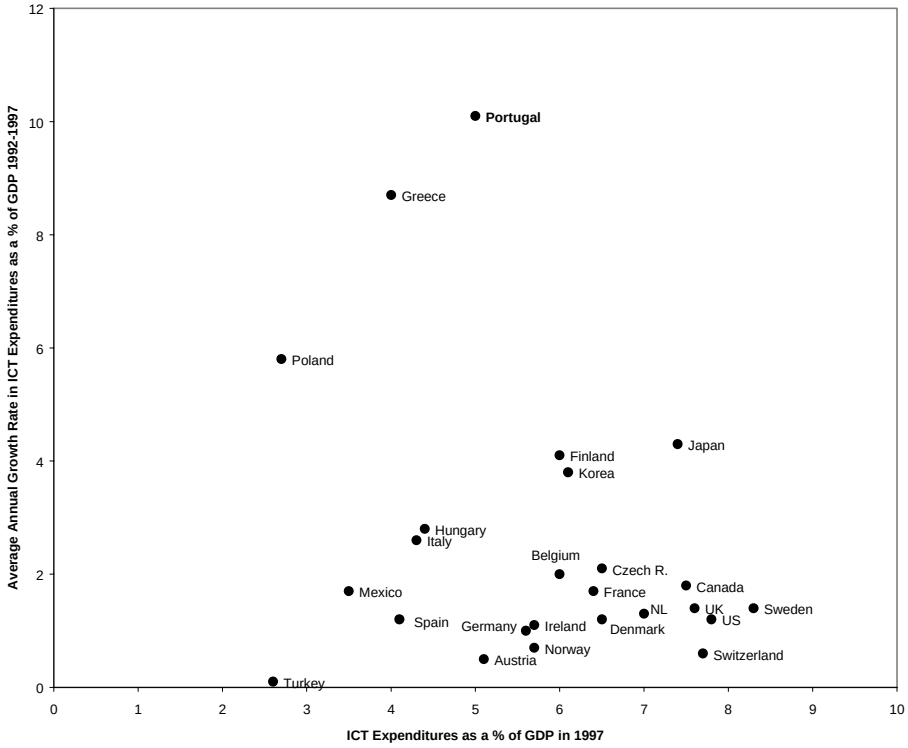

Figure 1. Information and Communication Technology (ICT) Intensity and Growth (1992-97); *Source*. [13]

Border Midland and Western Region	357.8 €
La Rioja	357.8 €
South Aegean	269.4 €
Ionian Islands	241.4 €
Baleares Islands	238.2 €
Western Greece	151.1 €
Açores	117.9 €
Highlands & Islands	98.4 €
Epirus	83.4 €
Alentejo	44.5 €
Peloponese	43.1 €
Continental Greece	42.8 €
Algarve	42.5 €
Centro	29.9 €
Norte	13.3 €
Southern Scotland	9.2 €
Lisboa e Vale do Tejo	6.8 €
Liguria	2.2 €

Table 1. Expected ICT Expenditure per capita for selected European Regions, 2000-06; Source: [8]

Besides large growth rates in ICT investments, the extent to which the Portuguese society is engaged in the knowledge economy comparatively to other nations can be analysed making use of the recently established systematic assessment by the World Economic Forum in collaboration with INSEAD and the World Bank's *info*Dev programme through the "networked readiness", as represented in Figure 2 for 2002 [12]. This indicator offers an aggregated idea of "the degree of preparation of a nation to participate in and benefit from ICT developments" and illustrates the still weak position of Portugal in the European context, only above Greece. The main point to note is that the results for Portugal and for most of the OECD countries appears to be dependent from other than the country's overall wealth (as measured in terms of GDP per capita). Considering the partial log regression plot included in the figure, Portugal is in fact entering the cluster of countries where the effect of increasing GDP on network readiness is less pronounced and other factors, namely at institutional and contextual level, have been shown to particularly influence country's competitiveness [10].

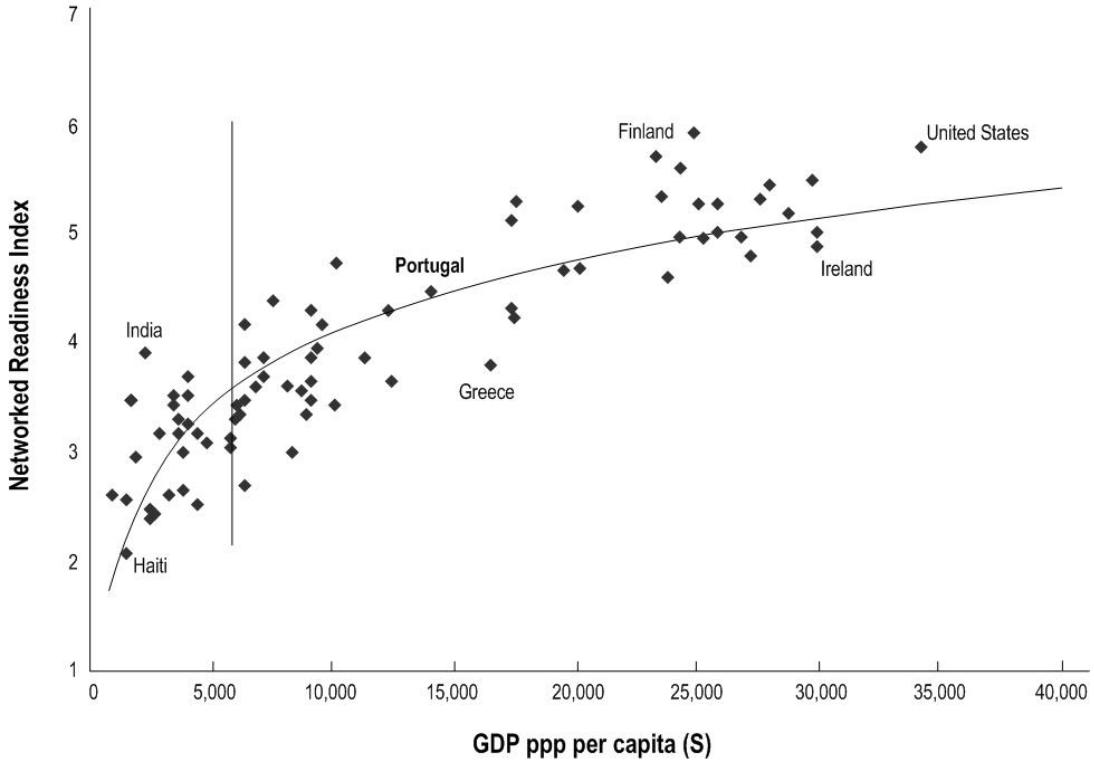

Figure 2. Network Readiness Index versus GDP (PPP) per capita, for 2002, with partial Log regression
Source: The Global information Technology Report 2002-2003: Readiness for the Network Society, World Economic Forum, [11]

The pattern of small absolute values regarding the mobilization of information society, but large variations, can be further analysed making use of a number of typical indicators to characterize the penetration of ICT´s in a country and, for example, figure 3 shows values for internet penetration rates, with Portugal getting the highest position in southern Europe for 2002 (Portugal 42%, while Spain 42%, Italy 40%, Greece 18%, with an EU average of 51%), although far away from typical north European penetration rates [14]. A similar picture can be obtained making use of Internet access in the household, with Portuguese rates of 31%, as compared with 29% for Spain and 9% for Greece, while 40% for the EU average and 74% for the USA, although Portugal exhibits growth rates between 2000 and 2002 considerably larger than the European average (namely 72% for Portugal, with 81% for Spain and 89% for France, as compared with 43% for EU average) [15]. Turning to the type of telecom infrastructure, the country follows typical average EU trends, with standard telephone lines as the most frequent connection to the Internet access at home (Portugal 74%, EU average 72%), followed by cable modem (Portugal 12%, EU average 7%). ISDN, ADSL and Wireless connections are still relatively low.

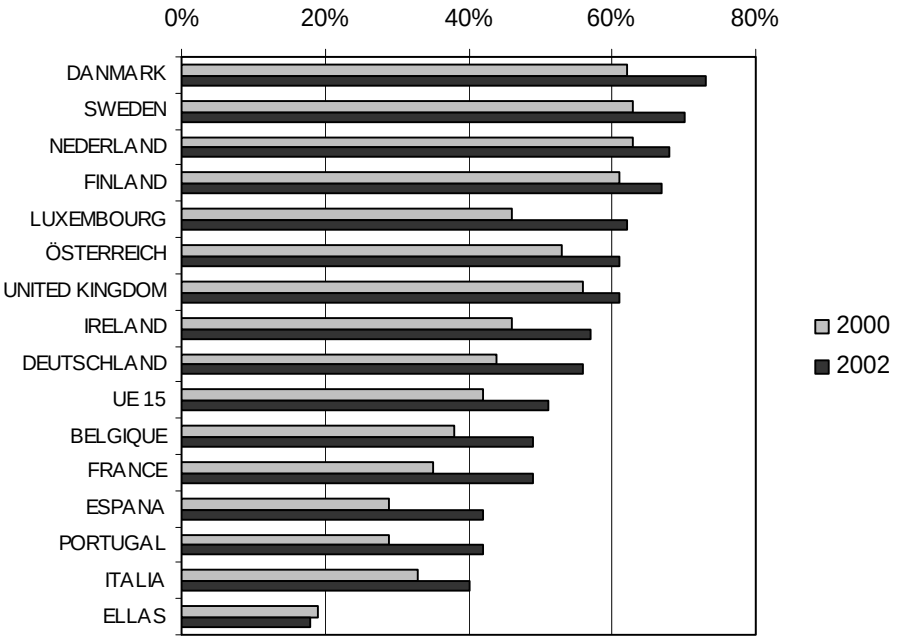

Figure 3 – Internet Penetration Rates in Europe (2000-2002)
Source: Eurobarometer 2003 [14]

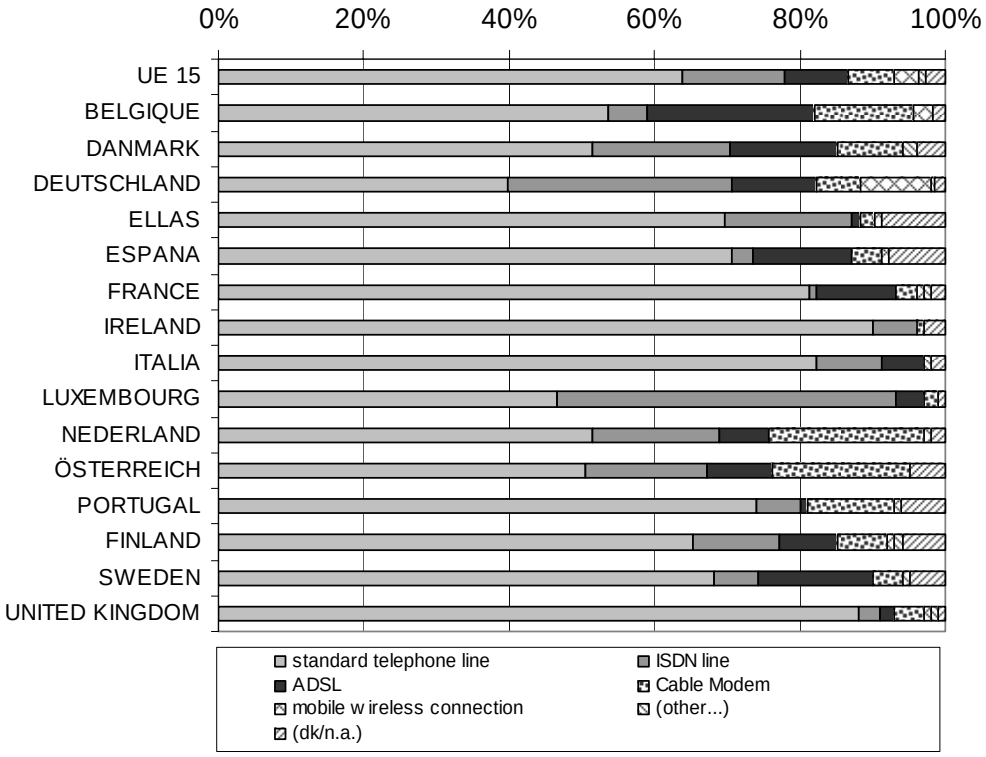

Figure 4 –Internet Access type (2000-2002); Source: Eurobarometer 2003 [14]

For this brief analysis of main figures characterizing the Portuguese context for the use and application of ICT´s in an international perspective, it should also be mentioned that the country has one of the lowest European usage rates of Internet for on-line purchases of products or services (9%, but only 1% frequently) and the third lowest percentage of Internet users that have already contacted the public administration [14]. These figures are important to set the context of information networks and clearly call our attention for the need to consider contextual levels beyond pure infrastructural issues, when considering measures to foster information networks.

But the figures presented above should be further explored in terms of the main point of this chapter, in that we are aimed to improve our understating of the conditions necessary for digital networks to succeed. Learning from the conceptualization of knowledge-based economies [6], it can be said that, fundamentally, the performance in knowledge-rich competitive environments in terms of innovative performance depend on the quality of human resources (their skills, competencies, education level, learning capability) and on the activities and incentives that are oriented towards the generation and diffusion of knowledge. But beyond human capital, which corresponds to the aggregation of an individual capacity for knowledge accumulation, developing a collective capacity for learning—as suggested by Wright [19] in the context of the US—is as, if not more important, than individual learning. Instead of individual or even aggregated human capital, a further important concept for learning seems to be social capital, as analysed by Conceição et al. [20], among others.

Before further exploring social capabilities and related issues associated with the development of digital networks, we present below further evidence on the penetration of ICT´s in Portugal through the analysis of specific projects aimed to build digital cities, namely making use of European structural funds.

3. Institutionalizing “digital cities”: evidence from Portugal

The evidence presented in this section is built on the analysis of sample projects for digital cities and regions in Portugal, which have been structured around the electronic provisioning of local government administrative services complemented by some pilot projects in areas such as e-business and telemedicine.

The first experiences in Portugal with digital cities started in 1998 through a program funded by the Portuguese Government and the European Union and involving 5 small and mid-sized cities (Aveiro, Bragança, Guarda, Marinha Grande, Castelo Branco) and 2 rural regions (Trás-os-montes and Alentejo), as identified in Figure 5. The main objectives of the program were to (a) improve the quality of life in cities; (b) contribute to development of peripheral areas; (c) improve local economy and employment; and (d) fight info-exclusion and help citizens with special needs [21].

The project sites were chosen for reasons which are out of the scope of this paper and we concentrate our analysis on issues associated with their effective implementation. Alentejo and Trás-os-montes are remote agricultural regions, among the least developed in Portugal and Europe, sparsely inhabited by an aging population. Both projects were designed to create new opportunities for the local population, mitigate social and economic disparities and promote regional networking. Aveiro is developing a true innovative and entrepreneurial image, in particular connection with the local university and the local branch of Portugal

Telecom, which includes important research and development activities. On the other hand, Marinha Grande is particularly engaged in traditional, labour-intensive industries and the digital city project has been particularly promoted through the industrial network associated with the local moulds industry. Both these two projects invested mainly on local competitiveness and competence building. Bragança, Guarda and Castelo Branco are peripheral cities with relative regional significance. Their approach was to support the adoption of information and communication technologies by individuals, firms, associations and local government and other public organizations.

Figure 5. Identification of main projects for the specific development of digital cities and regions, established over the period 1998-2001, making use of European structural funds. Adapted from [21]

In terms of regional penetration, Table 2 shows that the projects listed above covered about 11,30 % of the total Portuguese population (10,44% of the population under 15 years of age) and about 42% of the total surface of Portugal. All projects involved a broad range of relevant actors and change agents within each one of the territories being nonetheless always leaded by local municipalities. Local higher education institutions were particularly involved only in a limited number of projects (Aveiro, Bragança, Trás-os-Montes).

It should be noted that, at least for the initial projects analysed here, the institutional framework established by the central government was quite flexible and fostering local voluntary initiatives. It was based on the simple provision of guidelines focused on providing content and services related to local public administration and to specific activities with social implications (e.g., healthcare), economic impact (e.g, business-driven corporate networks for regional competitiveness), and aimed to promote cultural contents [22-25]. Initiatives to

mobilize and promote the adoption of the Information Society were part of various applications, although not always considered at the required level, at least beyond that given to the implementation of infrastructures [24].

Municipality	Pop.	(%)	Pop. < 15	(%)	Area (Km^2)	(%)
Aveiro	69.560	0,67%	12.160	0,73%	208	0,23%
Bragança	32.440	0,31%	4.760	0,29%	1.138	1,23%
Castelo Branco	54.260	0,52%	7.440	0,45%	1.440	1,56%
Guarda	38.560	0,37%	6.230	0,38%	709	0,77%
Marinha Grande	33.370	0,32%	5.050	0,30%	186	0,20%
Alentejo	510.690	4,93%	71.930	4,34%	27.227	29,55%
Trás-os-Montes	431.540	4,17%	65.450	3,95%	11.122	12,07%
Total	1.170.420	11,30%	173.020	10,44%	42.030	45,61%

Table 2. Characterization of digital city projects, in terms of population and area considered in each city/region Source: INE, 2001

Table 3 show sample data in terms of public funds made available to the seven projects mentioned above, illustrating diversified situations, with levels of funds per capita raging from low to moderate when compared with those considered within the overall usage of European structural funds [8]. Within the broad range of digital city projects considered at international level [4], *Aveiro Digital* represents an interesting case study in that it has comprised diversified initiatives promoted and coordinated by an autonomous organization formed among the local government, the local University and the incumbent Telecommunication operator, PT Telecom. It represented the result of a long preparation effort and provided the opportunity to evaluate concepts and dynamically testing ideas, involving a limited but well informed group of people [24].

Bragança Digital focused on creating basic ICT infrastructures and wireless networking environment for local government buildings, health institutions, educational institutions, and local employment agency to provide information and services to local citizens. Other initiatives included the provision of local products (www.rural.net), health, educational and e-business activities [25].

Guarda Digital was promoted by and organization formed by the municipality, local educational institutes, associations" and the incumbent telecommunication operator. It included pilot projects in healthcare e-business, tele-working and educational initiatives [26].

Castelo Branco Digital aimed to connect all public institutions (municipality, social security and health institutions) and local associations (sports, culture and business) to provide an integrated information network to citizens and tourists. For example, it has included the provision in rich media of old Portuguese theatre contents [27].

Marinha Grande Digital, as managed by the local municipality and the Technological Centre associated with the moulds and plastic injection industries, focused on creating an Extranet to provide business-related (mould, plastics and glass) content and services and on facilitating communication among companies and clients. Other initiatives included a centre of advanced telecommunications to promote the use of the Internet [28].

Trás-os-Montes Digital included regionally-based web contents (i.e., www.espigueiro.pt), managed by the local University, that aggregates content and services of 31 municipalities. The portal is managed by the local university and includes business and employment opportunities, geo-referenced information, healthcare facilities and technologies to coordinate medical services in rural areas [29].

Alentejo Digital brought together 47 municipalities and 3 regional agencies to create a regional information network to provide services and territory-related content to citizens and local firms through regional web-based contents. The main objective was to enable local government teams to learn, use and promote new technologies, namely computer network management and digital content production and publishing. An Intranet was set up linking all municipalities and regional agencies to enable the necessary collaborative work environment. About 50 people were recruited, mostly from local unemployment lists, to work on the project that lasted until July 2001 [30].

Project	Pop. (a)	Total investment	Investment p.c.
Aveiro	69.560	5,590,000 € (b)	80,39 €
Marinha Grande	33.370	1,200,000 € (c)	35,96 €
Bragança	32.440	1,044,000 € (d)	32,18 €
Castelo Branco	54.260	1,082,000 € (e)	19,94 €
Guarda	38.560	350,000 € (f)	9,08 €
Trás-os-Montes	431.540	1,735,000 € (g)	4,02 €
Alentejo	510.690	1,500,000 € (h)	2,94 €

Table 3. Public Funds Expenditure Per Capita in the first phase of the Digital Cities Program, 1998-2000.

Sources: (a) INE, 2001; (b) PACD, Final Evaluation Report, 2001; (c) ; (d) Associação para o Desenvolvimento de Bragança, Final Evaluation Report, February 2001; (e) personal communication http://www.dpp.pt/pdf/info52.pdf; (f) http://www.freipedro.pt/tb/110698/guarda3.htm; (g) personal communication; (h) http://home.telepac.pt/telepac/net/13/regionalismo_2.html.

4. Building a conceptual framework

We now turn to the analysis of the empirical evidence provided above and start by discussing necessary framework conditions for the success of digital cities. Then, we argue that knowledge-integrated communities are drivers of larger communities of users. Under this context, we continue our analysis by identifying elements that resembles a *knowledge based view of the territory* in order to discuss a conceptual framework for digital cities. We conclude

our analysis by presenting main policy implications derived from our conceptual understanding of digital cities.

But before turning to our analysis, it should be mentioned that our emphasis is on the conditions favouring the mobilization of the information society in less favourable zones in Europe, LFRs , which have been shown to lag behind the adoption of measures as rapidly or intensively as were the core regions of Europe [32]. In fact the type of structural funds used to support the projects discussed before derive from increasing awareness of that growing disparity in the European scenario, based on three arguments, namely. i) LFRs tend to get little new hardware and applications because of the weakness of their markets (lack of scale and agglomeration economies); ii) most LFRs have no track record of intensive interaction leading to innovation or new ways of learning and, therefore, most LFRs put their efforts into catching up, as opposed to proactive capacity building for IS; and iii) although the deregulation process and much of the hardware infrastructure may be national jurisdiction, applications and content are vital in regional terms.

4.1 Building infrastructures, capacity and connectivity across time and space

The evidence provided in the previous paragraphs may be interpreted in light of the framework identified in Figure 6, which considers the relative importance of the processes of making available and implementing infrastructures, together with the increasingly important role of incentives for mobilizing communities of practice and dynamically adapting institutions, and the overall context, towards innovative societies [1]. Under this conceptual approach, we may refer to three main levels of analysis, including *infrastructures*, *contents* and *context*, although there is a growing body of opinion that balanced information society depends on five mains aspects, namely: infrastructure, access, application and services, digital content development, and ICT skills development. In fact, the evidence provided by Lena Tsipouri throughout Europe [8] leaves us to jointly considered the first two levels under infrastructure, as well as to join application and services and digital content developments into a single level of analysis. In addition, we broaden the scope of the so-called ICT skills development to include other contextual issues and local characteristics of communities of practice.

The methodology uses the socio-technical approach to information systems [33], where the dynamic mutual adjustment of both technology and users determines its final performance. The contextual analysis provides to both content (existing, needed or planned) and communities brings their significance as nodes of information. Their relationships – information flows – must be mapped to the technological roadmap to determine the amount of change needed in the organization, community or society. Technology path-dependency and usage permanence must be well understood before designing, implementing or exploiting information systems. As a result, knowledge creation, accumulation and diffusion plays a critical role in this process.

Looking first at infrastructures in general, in the neoclassical view, they are related with the existing amount of labour, capital, and natural resources. The new growth theories bring to stage other important factor inputs, in particular human capital, and R&D expertise embodied in firms, universities, and laboratories [1, 2]. Thus, infrastructure will encompass, in addition to labor and capital, what we call technology infrastructure, or technostructure. Tassey [34] has proposed a definition that suits our discussion: technostructure consists of science, engineering, and technical knowledge embodied in human and organizational forms. In the

context of our analysis, we consider these three types of infrastructures in two main terms, namely physical infrastructures and web-based contents (or non-physical infrastructures), on which most of the sample projects considered in this paper have concentrated their investments. Table 6 provide the results of a brief analysis of main activities considered in the various digital city projects discussed above and list typical infrastructures that have been considered.

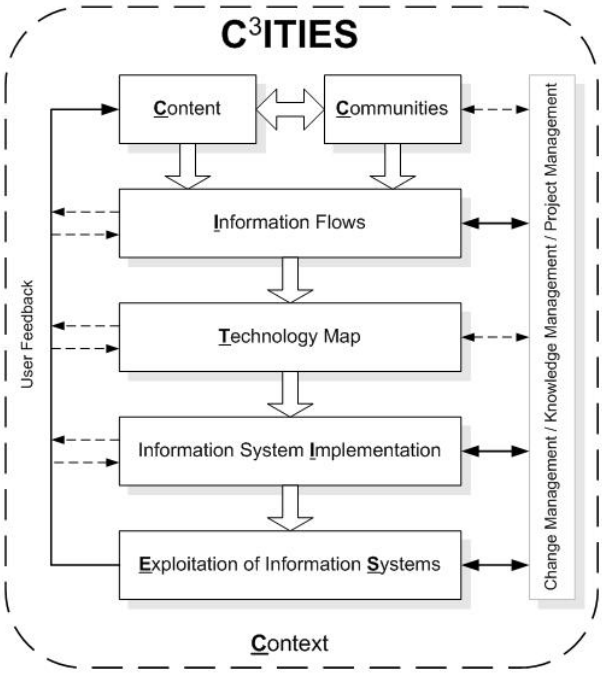

Figure 6. Framework for the analysis of digital cities, C^{3}ITIES, including the consideration of the overall context and communities of practice, with a diversified network of infrastructures and the processes of their implementation

Turning to incentives, current understanding of knowledge-driven activities based on endogenous growth theories are based on the existence of dynamic externalities and imperfect markets, and require a careful understanding of the structure of competition. On the one hand, because of the nature of knowledge, investment of private agents often fails to acknowledge spillover effects, or may not be able to anticipate the full extent to which there is further learning potential in a new technology. On the other hand, incentives to invest in new knowledge depend on the existence of some degree of monopolistic rents. These rents may not exist in latecomer countries exposed to international competition, if they are solely adopting foreign technology.

As a result, Conceição et al [1] call our attention that private investment levels (which result from the incentive structure provided by the market to economic agents) in activities with learning or spillover potential tend to be lower than the social optimum, and may even generate what is known in the literature as “low-level equilibrium traps” [35, 36]. In principle, these shortcomings of the market mechanism call for some sort of government intervention. Governments are concerned with making sure that societal costs and benefits are endogenized in the decisions of private firms. In a learning environment this may mean subsidizing specific activities, investing in education, or protecting infant industries [37, 38]. But

government intervention must balance the potential distortions on competition that may come from intervention with the needs to "correct market failures": artificial restraints on competition can also divert profits to activities other than building technological capabilities.

Projects	Physical Infrastructures		Content (non-physical infrastructures)		Context (e)
	Networking and Connectivty (a)	Information Systems (b)	Information Services (c)	Interactive Services (d)	
Aveiro	Local health institutions communication network; Internet access in public schools; People with special needs	Local public administration management information systems; Justice court Intranet; GIS	City guide; Entertainment, Arts & culture initiatives; Local government website	e-business, Agriculture; Job opportunities; Environment; Teleworking	Community building based on city metaphores
Bragança	Municipality communication network; Internet access in public schools	Municipality management information systems; GIS	City guide; Local government website	e-business; Telemedicine; Agriculture	
Guarda	Internet access in public schools		Local government website	e-business; Telemedicine; Teleworking	
Marinha Grande	Advanced telecommunication demonstration centre; Internet access in public schools	Local industries Knowledge network (Glass, moulding and plastics)			Mobilization of firms and public institutions for the use of ICT
Castelo Branco	Municipality communication network; Internet access in public schools		City guide; Local government website; Art & culture		
Trás-os-montes Digital	Internet access in public schools	Content management platform	Regional Portal	Telemedicine; Agricultural Network; Job opportunities	
Alentejo Digital	Intranet for 47 municipalities	Content management platform	Regional Portal	Job opportunities	

Table 6. Main initiatives developed within the Digital Cities Programme in Portugal (1998-2000)
(a) Networking and connectivity includes communication networks and Internet access.
(b) Information Systems includes technological components that store and process data like data bases, electronic mail, ERPs, management information systems, content management, application serves and business intelligence software
(c) On-line presence or downloadable forms
(d) Electronic form submission or interaction through the web
(e) Mobilization and context building initiatives

Against the background of the conditions described above, it is clear that digital cities cannot be promoted independently of an innovation policy fostering capacity and connectivity and that in turn innovation determines and is determined by the market. However, it is also clear that it will require an effective mix of public support mechanisms that take a relatively long-term perspective, taking into consideration specific regional and thematic aspects, thus promoting a diversified environment.

But still focusing on the issues of incentives and looking at their relation with the operational effectiveness of digital infrastructures, applications and services, the evidence is that the most important web contents associated with the digital city projects discussed before and summarized in Table 6 were available to the public domain only for the time public support was also available. Besides the notable exception of the Aveiro Digital Project, this result may be obvious for the local promoters of those projects, but should be acknowledge as a major issue for public policies fostering the information society. We will argue that early stage developments, as those we are considering throughout this paper, do require continuous support, together with adequate monitoring and evaluation procedures, in order to acquire the necessary strength for their sustainable development. Market mechanisms do not necessarily work at the level of the issues associated with digital cities, namely in less favourable zones, where incentives structures should de effectively designed and adapt over time.

Although incentives and infrastructure greatly inform our understanding of economic development, they do not tell the whole story about the differences across the various projects discussed in section 3, or even across the countries briefly discussed in section 2 above. This is because both incentives and infrastructure do not operate in a vacuum, being shaped by and shaping the particular context where they operate. In the scope of our analysis, the city or region must have embedded a set of social capabilities that define the context under which digital cities evolve. Consideration of contextual issues in building-up network societies have not always been considered in many different situation throughout the world, as acknowledge by Castells [7], among others, and Table 6 shows that specific measures to promote adequate contexts in the projects considered in this paper have also been scarce.

If one considers the broad social and economic context under which digital cities may be facilitated, we must consider the conditions for integrated learning processes. This has led Conceição, Heitor and Lundvall [2] to build on Lundvall and Johnson's learning economy [39] and to discuss the learning society in terms of innovation and competence building with social cohesion. They view innovation as the key process that characterizes a knowledge economy understood from a dynamic perspective, while competence is the foundation from which innovation emerges, and which allows many innovations to be enjoyed. In other words, it contributes both to the "generation" of innovations (on the supply side of the knowledge economy) and to the "utilization" of innovations (on the consumptions side of the knowledge economy). Conceptually, the foundations for the relationship between learning and economic growth have been addressed in the recent literature [40], with learning being reflected in improved skills in people and in the generation, diffusion, and usage of new ideas [41].

Further, the ability to learn seems to be the main driver of long-term growth, but learning can occur at different levels. Individual people, firms and organizations, and countries all are dependent of learning for development. Lamoreaux, Raff, and Temin [42] write: "more than any other factor, the ability to collect and use information effectively determines whether firms, industry groups, and even nations will succeed or fail." There are also different ways through which people, firms, and countries can learn. Learning can be an unintended consequence of experience and augmentation of scale, as formalized at the firm and then country level by Arrow [43]. On the contrary, formalized and intentional learning methods such as education, training or R&D is often the result of an utility maximization rational decision from the point of view of the firms. It is clear that previous evidence on digital cities [4], shows that we refer to complex networks of formal and informal learning processes leading to wealth creation and shared prosperity, but also to forms of inclusive development.

As we emphasized earlier, learning can occur in many shapes and forms, some of which are informal, some formal. As described before, the institutional framework that comprise the national and regional systems of innovation formalize the technological infrastructure critical to generate the learning processes for individuals, firms, and nations, that ultimately lead to long-term development. Thus, looking at a particular set of organizations, their capabilities and related institutions, provides important lessons for development. This is the reason we argue for the need to combine adequate infrastructures and incentives with institutions, to foster the necessary context for digital cities to succeed.

4.2 Knowledge Integrated Communities, KIC´s, and beyond

The analysis above is broad in scope and considers network societies as wide social and economic processes, which we argue occur across time and space and require the dynamic adaptation of infrastructures, incentives and institutions, in a way that calls our attention for the need to foster learning societies. However, the evidence of the projects discussed in this paper show that we must extend our analysis to other aspects of the learning society. This is because the experience of projects such as those developed in the cities of *Marinha Grande* and *Aveiro* clearly shows the important mutual relationships that specific project-based communities have on the facilitation of network societies, but also the fact that the implementation of digital cities may significantly improve the efficiency of those communities. In the following paragraphs, we extend this evidence and argue that the success of digital cities rely on the specific development of knowledge-integrated communities, KIC´s.

We refer to project-based communities, oriented to specific social and economic goals, that will benefit, and gain from, digital networks if particularly challenges by knowledge-based activities. In the case of *Marinha Grande* the evidence is that economically-oriented networks based on mould-forming companies has particularly launch business networks, which still require long-term processes and continuous funding, as well an adequate institutional setting. In this case, it should be noted the role of the related industrial association and technology centre in promoting the necessary links and networking facilities, which again support our previous analysis of the need to consider basic framework conditions.

In a different scale, but also using relatively reduced level of incentives, namely at an international scale, the evidence provided by the *RuralNet Project* developed in the city of *Bragança* also shows the critical importance of project-based mechanism to support and sustain digital cities. But of specific interest in our context, are some of the activities developed in *Aveiro*, in that knowledge-based activities could promote and sustain digital networks well beyond the period under which public incentives were made available.

The reason why knowledge-based activities are particularly prone to foster and sustain digital networks is because they will increasingly rely on “distributed knowledge bases”, as a systematically coherent set of knowledge, maintained across an economically and/or socially integrated set of agents and institutions, as discussed by Smith [44] and Conceição et al [1], among others. The relevance of considering distributed knowledge bases across economically and/or socially integrated set of agents and institutions leads us to the concept of social capital. In the broadest sense, social capital is associated with the “social capabilities” [42] that allow a country or region to move forward in the process of development. In a more sophisticated treatment, Coleman [45] states that social capital is “a variety of different entities, with two elements in common: they all consist of some aspect of social infrastructure,

and they facilitate certain actions of actors—whether personal or corporate actors—within the structure." The relationship of social capital for the economic performance of nations was recognized by Olson [46] and North [47], in broad descriptions of the process of development.

Referring again to the evidence provided by some of the projects discussed above, namely those at Aveiro, the role of higher education institutions appear to be particularly important in fostering network activities, namely in the form of knowledge-based communities. Following the analysis of Castells and Hall [48], "it takes a very special kind of university, and a very specific set of linkages to industrial and commercial development, for a university to be able to play a role it often claims to play in the information-based economy". Definitely, those technical universities that are pure teaching factories, or work under a bureaucratic structure, are unlikely to act as generators of advanced technological milieu. Again, this recalls our attention to the role of institutions in planning digital cities and promoting their impact.

Still in this context, Bill Mitchell [49] argues that the most obvious advantage of digital networking is that it provides an efficient way of "aggregating specialized expertise" through "common access to project databases, compatible software tools, and advanced telecommunication capabilities". But, he emphasizes that "it does little about the problems of creating trust and confidence, and of building intellectual and social capital for the long term", requiring the development and maintenance over weeks and months of "project-based learning communities" looking at a common and complex target. Long term collaborations can provide a more permanent framework of online resource-sharing, and examples of such an initiative, shows the need to bring scale and diversity, beyond time. Based on this example, Mitchell concludes that we should look beyond the popular idea of learning communities and seek to produce communities that "motivate and sustain creative discourse yielding original intellectual products such as architectural and engineering designs", the so-called "creative communities".

A final remark associated with the form and role KIC´s may play in the process fostering university-based network societies, should be discussed in terms of the evidence provided by the Program "Ciência Viva" in Portugal, namely in association with some of the projects discussed above [50]. It refers to specific networks formed among basic and secondary schools with university groups and research centres through project-based activities oriented to promote a culture of learning. Beyond the critically important role of this type of activities, as explained by Ziman [51], among others, taking Pine and Gilmore's contentions [52] about what they termed "the experience economy" and the role experiences play in building stronger and more personal relationships in the corporate world, our argument is that schools, and universities in particular, must deliver authentic experiences to build and encourage sustainable and entrepreneurial growth. Pine and Gilmore explore the idea of experiences as a fourth economic offering, as distinct from services as services are from goods, but one that has until now gone largely unrecognised. While services may be considered as a set of intangible activities carried out on behalf of a person, experiences are memorable events that engage that person in an individual way, so that they determine and guide transformations. Experiencing entrepreneurial processes at the school (and the university, in particular) thus sets the stage for the societal transformations required to progress successfully towards innovative societies.

From the analysis above, it is clear that knowledge-integrated communities may develop over different institutional, thematic and social frameworks and table 8 summarizes the evidence provided by the various projects analysed.

Driving factor	Sample Experiences	Remarks
Scientific	*Biorede* - Biology knowledge network about local biodiversity, molecular biology and estuary ecosystems launched at Aveiro (www.biorede.pt)	Website developed and managed by Research Centre
Education / Training	"Engineering in Portugal", providing historical data and information for Basic and Secondary Schools, as well as university students (http://www.engenharia.com.pt/)	Learning materials and information exchange between experts, teachers and students; Website managed by Research Centre
Public Health	Health information and communication network of the Bragança Digital City extension services (www.espigueiro.pt/servico_cooperativo/servico_coop_puh.html)	Portable computers and Internet access to foster the communication and information exchange between doctors and patients
Managing Public Risks	Water quality monitoring and public diffusion system (www.simoqua.pt)	Raise public awareness about water quality, flooding and other public risks
Corporate strategy and competitiveness	Marinha Grande local-industry (moulding, plastics and glass) network (www.marinhagrandedigital.com/)	Extranet managed by Technological Centre

Table 7. Typical experiences fostering *knowledge-integrated communities*, KIC´s, as identified in the various digital city projects analysed and other sample initiatives

4.3 Striving for a conceptual framework: fostering a knowledge-base view of the territory

The previous paragraphs provide empirical evidence on specific digital city projects developed in Portugal in the recent past, as well as on particular framework conditions for their success, but now we turn to the discussion of a conceptual framework required to improve our understanding of digital cities and networks.

It is clear that focusing on digital cities, we must consider the conditions that foster innovation and the related processes of knowledge sharing in local contexts. Traditional neoclassical approaches in industrial economics have emphasized the analysis of the microeconomic behaviour of firms and built theories specialized in the American and Anglo-Saxon systems and related market dynamics. Following the analysis of Conceição et al [1], it provides an excellent context to understand incentive structures and outcomes, but ignores most of the remaining issues associated with learning discussed above. Evolutionary economics focuses on routines and capabilities rather than incentives to improve our understanding of learning processes and the role of institutions in economic development. Nevertheless, they have not addressed the specific historical context of any region, namely those characterized by late industrialization [53]. Building on the evolutionary approaches and in system theory, the concept of "national system of innovation" [54-56] has led to numerous studies of individual countries, but there is still a long way to go in order to assess the specificity of metropolitan systems or late industrialized regions.

The importance of the learning dynamics of firms and regions has been increasingly considered as key to the processes of knowledge accumulation, innovation and growth [57]. In this respect, "firm competencies" affect the ability of firms to innovate and shape their technology trajectories. Building on this idea, Conceição, Heitor and Lundvall [2] discuss the need to consider the systemic nature of innovation together with processes of competence building.

At the same time, the spatial patterns of innovation and the related geographical dimension of economic and social development have witnessed a renewed and increasing interest in the literature [53, 58], but attention is to be focused on the ability to build social capital, including interactive learning, local externalities, and networks among institutions [59]. This focus on relational assets is part of the "institutional turn" in regional development studies, as a result of the relative failure of classical approaches which sought to privilege either "state-led" or "market-driven" processes, regardless of time, space, and milieu.

In conceptual terms, we attempt to explore features in the seminal work of Nelson and Winter [57], for which organizations know how to do things through simple rules and procedures (routines) which represent the knowledge memory of the organization. Even firms in the same industry differ in the sense that they accumulate and develop idiosyncratic routines, which form the basis of the firms' distinctive capabilities. Fundamental to the idea of skills and routines is that they are constituted essentially by tacit knowledge and are thus not easily replicated. Replication of routines is thus possible only as a costly, time-consuming process of copying an existing pattern of productive activity. The dynamics in the theory is brought about by the processes of searching for new routines and creating variety and mutations amongst firms, which are then subject to selection processes. The combined interaction of search and selection processes form the basis of the evolutionary approach and relate Nelson and Winter's approach to the theories of organizational learning and population ecology respectively. The routines are thus seen as the knowledge genes of the organization, being transformed by organizational learning and innovation. Although Nelson and Winter's work provided a conceptual foundation for a knowledge-based view of the firm, an essential development was a deeper understanding of what constitutes knowledge, which we attempt to extend for a territory bases. Figure 7 attempts to provide a schematic representation of a possible framework of analysis considering main functions to satisfy the knowledge-based view presented here.

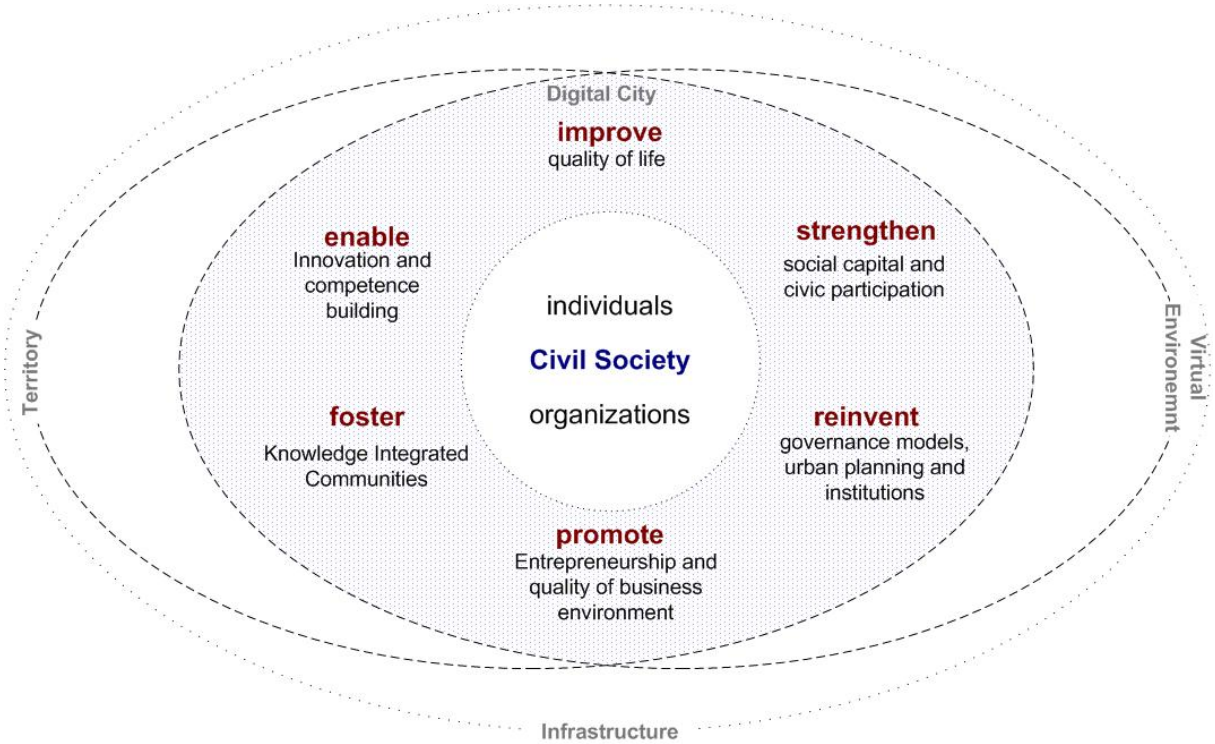

Figure 7. Schematic representation of a possible framework for the development of digital cities

In this context, a knowledge-based view of the territory assumes that individual, firms and organizations operate in dynamic environments, where markets and technology are changing fast and in unpredictable ways, as discussed by Eisenhardt and Santos for the open discussion of emerging theories of strategy [60]. It also assumes a highly competitive setting, with those agents operating within ecologies of learning, interacting and adapting to the environment. In this framework, organizational capabilities or competencies are understood as clusters of knowledge sets and routines that are translated into distinctive activities. Dynamic capabilities are those that enable individuals and firms to build, integrate and reconfigure internal and external competencies. The knowledge that is embedded in capabilities is a complex and dynamic combination of tacit and explicit knowledge. Individuals operate within organizational contexts in order to be able to share and use their specialized knowledge. As a result, digital cities should consider *communities of users* and build a context favourable to their increasing participation over time.

Following the analysis of Santos and Heitor [61], a determinant of the effectiveness of those communities of users is the level of the absorptive capacity, as identified by Cohen and Levinthal [62] as the ability of a firm to recognize the value of new external information, assimilate it, and apply it to commercial ends. Extending this concept for the collective dimension typical of the territory, the absorptive capacity should be largely a function of the level of the regions' prior knowledge (which emphasizes the cumulative nature of knowledge) and is also history or path dependent (which emphasizes the importance of earlier decisions). The level of absorptive capacity is heavily dependent on the level of absorptive capacity of each actor (individuals and organizations) in the territory, but is different form the sum of the parts. It not only depends on the interface with the environment but also involves the internal transfer and communication of knowledge. This concept calls attention to the internal channels of communication, to the diffusion of knowledge in the region, and to the pattern of investments.

4.4 Which Policy implications?

Knowledge creation and competence building at the regional level, when considered as a dynamic process of learning, can mitigate the uncertainty about the future of urban areas. Metropolitan areas must be liveable and attractive to all citizens, most of them needing urgent sustainable and innovative solutions to overcrowding, pollution, traffic jams, insecurity, social inequalities, unemployment, and population aging. City authorities will have to invent new models of participative governance and learn to manage change. Information rich networks can provide the main resources to overcome physical barriers to share interests and experiences to prop up creativity and entrepreneurship and to diminish the pressure on urban areas. We conclude by recommending elements and components for policy making and design of digital cities in Portugal, arguing for the need to promote *regional systems of innovation and competence building*.

Referring to recent work within the framework of the OECD International Futures Program, two broad policy-related conclusions apply not only to OECD countries in general, but to a large extent also to the case of Portuguese regions. The first is that if one is to build on the opportunities offered by the considerable progress that has been made in key technological sectors, if one is to reap to the full the economic benefits of rapidly integrating markets and the emerging knowledge society; and if solutions are to be found to tackling the challenges that the management of such rapidly changing world raises, then what is needed are innovative, creative societies. The second is that in achieving that higher degree of

innovativeness and creativity, policy will matter. The way ahead does not necessarily mean less government, not less policy but -- certainly in some key areas -- different policy.

Just because we are headed into a rapidly changing world in the coming decades does not mean that we have to throw out all policies and make a completely fresh start. Indeed, some policies that have proved their worth in the past may well continue to do so in the future. However, it is clear that in other policy areas at least incremental adjustments are called for, and in yet others some radical new thinking is required. This provides, in fact, a simple but convenient framework for looking at the role of general policies in the future and their implications for innovation: -- 1) policy continuity 2) policy reform 3) policy breakthroughs.

In Portugal, most of the complex social, economic and political advances towards the Information Society are governed by public decisions. The evidence provided in this paper shows that investments in ICT infrastructures, although very necessary, haven't been sufficient to create a sustainable knowledge-based living and working environment. Consistent public policies, innovative regulatory frameworks and strong incentives are thus needed to create over time the conditions to catch up with more developed societies and mitigate the uncertainty associated with the adjustment process [6].

Within this perspective, our analysis calls for policies that consider long term approaches of dynamic environments, which require to be continuously monitored and evaluated. Specific incentives for infrastructures should continue, but articulated with the need to foster knowledge integrated communities as drivers of larger communities of users. This requires a continuous pubic effort, but also a better understanding of the effectiveness of the mix of public support mechanisms and private incentives for the development of digital cities.

5. Summary and Main Conclusions

The main contribution of the paper is presented in terms of a knowledge-based view of the territory to foster institutionally organized metropolitan systems of innovation and competence building. The analysis is based on observations in different Portuguese metropolitan areas and regions with the ultimate goal of increasing regional competitiveness, by promoting public awareness and participation in decision-making processes. It is argued that the territory is a basic infrastructure that justifies and invites for the construction of several layers of information, but above all for communication infrastructures and digital contents, but well arranged with local contexts. It is suggested that knowledge driven communities, KIC´s, are importnat drivers of larger communities of users and different types of KIC´s are identified. Particular attention is suggested for those established among basic and secondary schools with university and research groups and evidence is provided from sample case studies in Portugal.

Our analysis led us to suggest that while the role of institutions needs to be re-examined, the variety of demands and the continuously changing social and economic environment is calling for diversified systems able to cope with the need to produce policies that nurture and enhance the learning society. We refer to the need for individuals, firms and organizations to operate in dynamic environments, where markets and technology are changing fast and in unpredictable ways. This calls for the need to combine adequate infrastructures and incentives with institutions, to foster the necessary context for digital cities to succeed. The institutional

framework should be dynamically considered in order to foster local conditions over time, and this does not necessarily mean less government, but rather continuous public support and monitoring.

Acknowledgments
We acknowledge the collaboration and many useful conversations with the administration of the Program for the Information Society in Portugal, POSI. The collaboration of staff at *Aveiro Digital City* and the *Council of Aveiro* is also recognized, as well as the information provided by staff of the Bragança´s Polytechnic Institute and the *RuralNet* Project.

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