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Building the Information Society in Portugal: Lessons from the Digital Cities Program 1998-2000

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INTRODUCTION

Society and technologies co-evolve by both shaping and being shaped by the places and spaces where we live. The variety and intricacy of these recombination processes contribute profoundly to the current diversity of spatial structures and meanings of both cities and country sides. Information and communication technologies (ICT) can offer new scenarios for territorial development and provide a new kind of networked infrastructure that will have a profound and lasting effect on the patterns and shapes of urban areas. One of these scenarios is the concept of “digital cities”.

There are five basic design patterns for digital cities: (a) highly wired territory; (b) community network; (c) 3D or 2D representation of physical cities; (d) local government portal; and (e) commercial city guides (Schuler, 2002). While the first pattern concentrates on digital infrastructure, the other four are manifestations of different aspects of urban everyday life on the Internet. Recombinations as well as whole new patterns that emulate the vast diversity of real cities are also emerging.

Building on case studies of selected Portuguese cities and regions which have been engaged in “digital cities and regions” projects, this paper will go beyond the patterns mentioned above and will discuss the main challenges and opportunities for mobilizing the information society in Europe, with emphasis for the conditions affecting less favored regions. Moreover, it will also explore the convergence of telecommunications and computer networks within the urban context as reflecting a new city infrastructure supporting everyday life and mobility.

Existing literature on the subject of digital cities often focuses on technological innovations as the main, if not the only, driver of social transformation. As the new digital technologies become embedded in daily life as an “invisible” infrastructure, mobilization and the capacity of absorption and diffusion of technologies seems to be critical to the development of the information society. Within this context one may ask: *What critical factors can enable a digital city to mobilize individuals, communities and organizations for the construction of an information society in Europe? What sort of public policies must be taken into consideration to promote these factors?* These broad questions build on a comprehensive set of data on digital cities presented in a previous work (Moutinho and Heitor, 2004; 2005) and on the need to continuously adapt European and national policies aiming to foster innovation and competitiveness in the information industries. It will also be argued that current broadly target public policies to bridge the digital divide may not necessarily stimulate the construction of the information society. Focusing on communities of practice, interest or proximity might give better results over both the medium and long term.

First, the concept of a digital city and its relationship with physical cities will be discussed. Then, the Portuguese Digital Cities Program will be contextualized within the Portuguese and European strategies and action plans for the development of the Information Society. This will be followed by a brief presentation of the Portuguese Digital Cities Program, focusing on the Aveiro Digital City project. The last section will discuss the existing evidence, present some conclusions, and recommend courses of action for future public policies.

WHAT IS A DIGITAL CITY?

The first known “digital city” was based on Amsterdam’s well studied community network experiment in 1994 (DDS – De Digitale Stad), based on the FreeNets and Community Networks in the USA and Canada (Besselaar and Beckers, 1998; Besselaar, 2000). The goal was to provide an electronic space for political discussion and participation in the ten weeks that preceded local elections. But, as one could glean from the examples mentioned in the first section, there is no current unified agreement and understanding concerning the concept of digital cities.

The first Portuguese digital cities' projects were also much diversified. Perhaps their diverse interpretations reflect the relative infancy of this concept. Innovations are often fuzzy at the beginning, and it takes a while before they

establish their own evolutionary paths based on pre-existing ones, or simply fade out. Thus maybe these varied readings about digital cities simply mirror the different views about real cities, and will coexist for a long time.

Architects and urban planners usually concentrate on form, patterns, structure and relationships among the various components, both living and non-living, of a city (Kostof, 1991). Engineers mostly give attention to the infrastructures, utilities and artifacts that make cities work. Urban economists prefer to analyze the spatial aspects of decision making of firms and households (O'Sullivan, 2003). Sociologists and geographers are inclined towards studying interactions among people and communities within the urban environment and their effect on the common production of the urban spaces and places (Castells, 1989; Valentine, 2001).

Most of these perspectives tend to enhance one or another aspect of urban life in order to explain or predict, at least partially, the outcome of planning, implementation or living strategies. At one point however, most of the perspectives converge: cities are currently the foci of the creativity and innovation that continuously co-evolve within the economic, social, cultural and political society, institutions and technology. As pointed out by Zook (2001), "despite the space transcending ability of Internet technology, [...] the commercial Internet clustered in a few regions within the United States during the period from 1994 to 2000. The existence of these agglomerations runs counter to expectations that the Internet would bring about the "end of geography".

Mobilization is simultaneously a driver and outcome when building the information society. Cities, and in our case digital cities, are places of dense and energized crowding (using Kostof's (1991) image about the urban processes) that can provide an adequate environment for creativity and innovation and knowledge spillovers through intensive virtual or face-to-face contacts and word-of-mouth (O'Sullivan, 2003).

For the purposes of this paper, the concept employed will be that of the digital city as a new layer of urban networked infrastructure, based on telecommunications and computers, supporting and augmenting everyday life.

EUROPEAN AND PORTUGUESE CONTEXTS

The circumstances that gave birth to the Portuguese Digital Cities Program in 1998 are linked to several agendas and action plans for the development of the Information Society in Europe, starting with the "White Paper on Growth, Competitiveness, and Employment: The challenges and ways forward into the 21st century" (European Commission, 1993).

The development of the Information Society in Europe – or, to use the term currently preferred in the European Union, the 'Knowledge-based Society' – must be understood, as pointed out by Barry (2001), in the context of an "era obsessed by a series of interconnected technological problems: with the maintenance of technological competitiveness and the improvement of research productivity; with the need to patent and protect intellectual property; with the

dangers posed by the unintended consequences of technological development; with the public understanding of science; with the prospects of e-commerce and electronic democracy; and with the need for lifelong learning in the face of rapid technical change”.

The European Union follows a dual strategy. While member states are stimulated to address national challenges and opportunities with local and/or regional initiatives in a bottom-up approach, the European Commission plays an important role defining top-down strategies, policies and standards for the European Union as a whole (Dearnley and Feather, 2001). Therefore, in order to fully realize the varied aspects of the information society in Europe, it is important to follow both national and European paths, namely by revising the strategic documents that establish visions, goals, demonstration projects and respective evaluation frameworks.

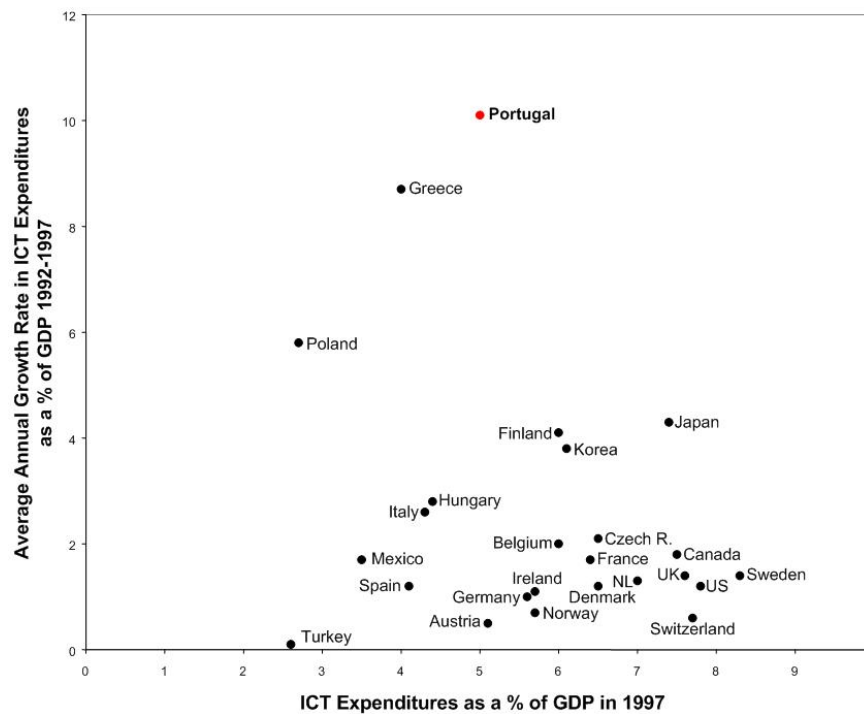
What was particularly significant for the digital cities' projects in Portugal were the areas of application set forth in the “Bangemann Report”, prepared in 1994 for the European Council by Members of the High-Level Group on the Information Society as providing the building blocks of the information society, as follows: teleworking (more jobs and new jobs for a mobile society); distance learning (life long learning for a changing society); networking of Universities and research centres (networking Europe's brain power); telematic services for SMEs (re-launching a main engine for growth and employment in Europe); road traffic management (electronic roads for a better quality of life); air traffic control (an electronic airway for Europe); health care networks (less costly and more effective healthcare systems for Europe's citizens); electronic bid tendering (more effective public administration at a lower cost); public administration networks (better government, cheaper government) and city information highways (bringing the information society into the home).

In April 1997, the “Portuguese Information Society Green Book”, published by the “Information Society Mission” taskforce (1997) which had been created a year earlier, established a set of key policies for the development of the Information Society in Portugal. It addressed a broad range of issues related with electronic democracy, the digital divide, electronic government, knowledge networks (R&D, Universities and schools), digital business environments, employment, the new economy (software, digital contents, entertainment, telecommunications), institutional and legislative frameworks, security and privacy, as well as others.

The following year, 1998, the Portuguese Digital Cities Program was launched (Veiga, 2000). It proposed four action lines: (a) improve the quality of life in cities, mainly through the provision of electronic local administration services and telemedicine; (b) contribute to the development of peripheral areas; (c) improve the local economy and enhance employment by providing access to new markets, teleworking and e-commerce; and (d) contribute to fight info-exclusion and help citizens with special needs. Several cities or regions were invited to participate in the program using a diverse mix of organizations, mainly led by local governments, universities, or regional agencies. Nonetheless,

the basic content of each project was somehow predetermined by previous beliefs and only occasionally would local needs and expectations be addressed.

Figure 1.
ICT Intensity and Growth (1992-97)



Source: OECD, 2000

In order to better understand the national context it would help to pay attention to the local diffusion of ICTs in comparison with other European countries. Fig 1. presents the intensity of ICT expenditures in 1997 against the growth rate of this intensity from 1992 to 1997. Following a recent analysis for knowledge-based industries (Conceição and Heitor, 2003), the results show that Portugal was the leading OECD country in the rate of growth for ICT expenditures from 1992 to 1997, with a growth rate of more than 10%, mainly accounted for by increases in expenditures for telecommunications (about 9%). Expenditures in IT services and software are particularly low, below 1%, and only Turkey, Greece and Poland have lower shares of expenditure on IT software and services. The growth in this category has been equally dismal, below 2% a year.

Figure 1 shows large variations associated with countries characterized by small absolute values, exhibiting the typical patterns industrialization such as

Portugal. In addition, the results may present indications of a process whereby latecomer countries become engaged in the new techno-economic paradigm (Freeman and Louçã, 2002). 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.

Table 1
Expected ICT Expenditure per capita for selected European Regions, 2000-06

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 €
Lisbon and Tagus Valley	6.8 €
Liguria	2.2 €

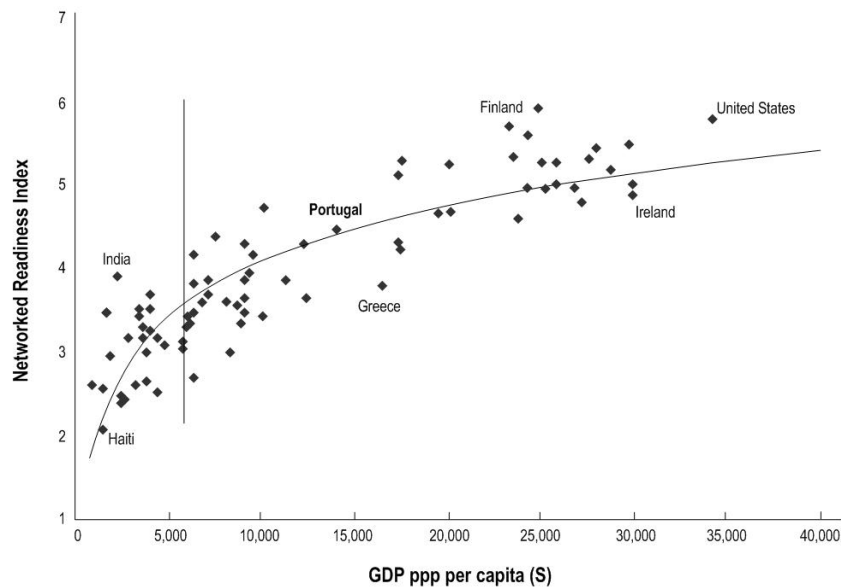
Source: Tsipouris, 2002

Evidence of the still low absolute value of 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 indicated information society actions and that provided the necessary financial information (Tsipouris, 2002). It is clear that the Table refers, above all, to those regions that have attracted European structural funds. As a result it is important to take into consideration the wide diversity of situations and framework conditions for attracting these funds, which clearly influence any analysis undertaken based on their distribution. For the purposes of this paper it is interesting to attempt to define the extent to which the performance of digital

networks and cities would depend exclusively on funding limitations, as well as on the capacity to attract them.

Besides its high growth rate in ICT investments, the extent to which the Portuguese society is engaged in the knowledge economy compared to other nations can be analyzed making use of the recently established systematic assessment by the World Economic Forum in collaboration with INSEAD and the World Bank's *infoDev* programme using "networked readiness", as represented in Figure 2 for 2002 (Dutta and Jain, 2003).

Figure 2.
Network Readiness Index versus GDP (PPP) per capita, for 2002, with partial Log regression



Source: Dutta and Jain, 2003

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, above Greece only. The main point to note is that the results for Portugal and for most of the OECD countries appear to be dependent more on each 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 the institutional and contextual levels,

have been shown to particularly influence the country's competitiveness (Conceição and Heitor, 2003).

The earlier-mentioned challenges associated with latecomer industrialization, and the relative positioning of Portugal in the international scenario at the outset of the 21st century demonstrate that Portugal consistently ranks as one of the poorest performing countries in Europe.

THE PORTUGUESE DIGITAL CITIES PROGRAM

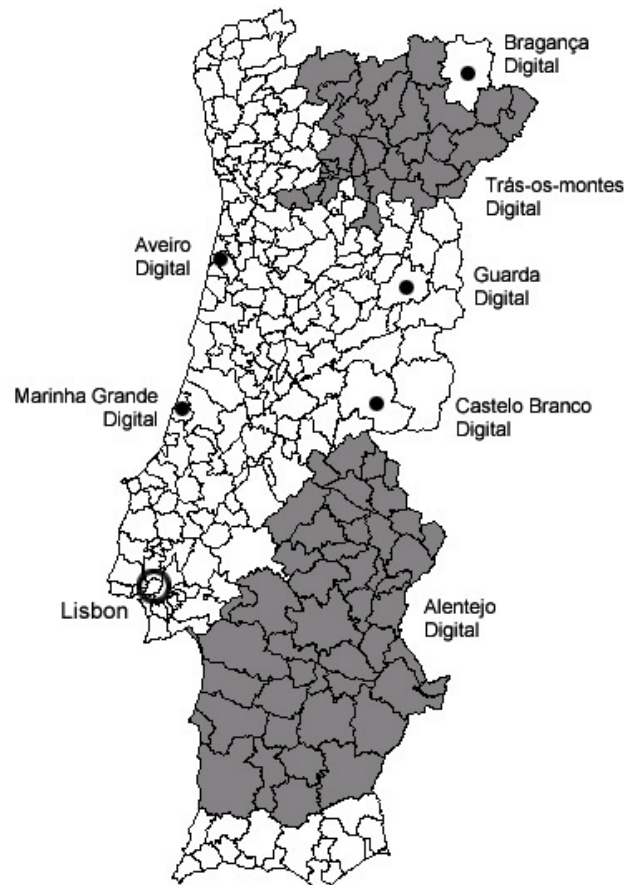
The Portuguese Digital Cities Program was set up by the Portuguese Government through the Ministry of Science and Technology in 1998 and jointly funded by the Portuguese Science and Technology Foundation (25%) and the European Union (75%). There were several simultaneous initiatives related to the diffusion of ICT at a national level, e.g. Internet access in schools (RCTS network), community building portal (Mosaico / Terra-à-vista), and a successful electronic government one stop shop (Infocid). Nonetheless, the digital cities projects were the only integrated initiatives related to the territory and specifically designed for the diffusion of ICT at the local level, covering multi-aspects of society; collective and individual, public and private.

The Program involved 2 rural regions (Trás-os-montes and Alentejo) and 5 small and mid-sized cities (Bragança, Guarda, Castelo Branco, Marinha Grande and Aveiro), as identified in Figure 3. The main objectives of the program were to (a) improve the quality of life in cities; (b) contribute to the development of peripheral areas; (c) improve local economy and employment; and (d) fight info-exclusion and help citizens with special needs (MCT, 1997).

In terms of regional penetration, these projects covered about 11.3% 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 of the territories, but nonetheless were always led by local municipalities. Local higher education institutions were particularly involved only in a limited number of projects (Aveiro, Bragança, Trás-os-Montes).

Alentejo, literally "beyond the Tagus River", is an agricultural region famous for its cork plantations. The population density is very low, less than 1/5 of the national average. Its relatively large territory, constituting roughly to one third of the total national area, lies in the south of Portugal. It is limited to the north by the Tagus River, to the South by the Monchique mountain ridge and the Algarve and to the east by the Spanish regions of Extremadura and Andalusia. To the west lies the Atlantic Ocean. The economy relies on forestry, livestock, mining, and agriculture, notably olive oil and wine.

Figure 3.
The main projects for the specific development of digital cities and regions,
established over the period 1998-2000



Alentejo Digital brought together 47 municipalities and 3 regional agencies in order to create a regional information network to provide services and territory-related content to citizens and local firms through regional content based web sites. 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, aimed at creating the necessary collaborative work environment. About 50 people were recruited,

mostly from local unemployment lists, to work on the project, which lasted until July 2001 (<http://www.alentejodigital.pt/>).

Table 2
Characterization of digital city projects, in terms of population and area considered in each city/region

Geography	Population	(%) total population	Pop. < 15	(%) total pop. < 15	Area (Km ²)	(%) total area
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%

Source: INE, 2001

Trás-os-montes, literally “behind the mountains”, is a remote region in the northeastern corner of Portugal, one of the poorest in Europe, riddled with desertification, an aging population, and socio-economic exclusion. Its population is largely rural and sparsely disseminated. Both agriculture and industry are still underdeveloped in the area. Accessibility is difficult and public transportation is infrequent. There is a noticeable lack of institutions involved in R&D, technical training, education or technological support, as well as regional business networks or associations. Therefore, there are very few opportunities for employment in the technology or information industries (Marques, 2004).

Trás-os-Montes Digital included regionally-based web contents (i.e., www.espigueiro.pt), which aggregated the 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 aimed at coordinating medical services in rural areas (Morgado, 2003a, 2003b).

Bragança belongs geographically to the Trás-os-montes region and experiences the same regional constraints. Bragança Digital, led by the local municipality and the local Polytechnical Institute, focused on creating basic ICT infrastructures and a wireless networking environment for local government buildings, health institutions, educational institutions, and the local employment agency, in order to provide information and services to local citizens. Other initiatives included the provision of local products (www.rural.net), and health,

educational and e-business activities (Association for the Development of Bragança Digital City, 2001).

Guarda and Castelo Branco are peripheral cities that nonetheless play an important role as regional centralities. The subordinated network of small urban areas, organized along the main accesses to Spain and Europe, are characterized by low-density settlements that rely mainly on agriculture and livestock and some related light industries. Both cities are located in the neighborhood of the Estrela Mountains, the highest peak in continental Portugal.

Guarda Digital was promoted by an 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 (<http://www.ipg.pt/adsi/>).

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 included the provision in rich media of old Portuguese theatre classics (http://www.cm-castelobranco.pt/cb_digital/).

Marinha Grande is a dynamic city, particularly engaged in traditional, labour-intensive industries (e.g. glass and moulding industries) and has been heavily investing in local competitiveness and competence building. 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) contents and services and on facilitating communication among companies and clients. Other initiatives included a centre of advanced telecommunications aimed at promoting the use of the Internet

(<http://www.marinhagrandedigital.com/>).

Table 3
Public Funds' Expenditure Per Capita in the Digital Cities Program, 1998-2000

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 €

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.

AVEIRO DIGITAL

Aveiro is a seaport, located at the Vouga estuary, with a population of 69,560. The city's innovative and active character, although of a recent nature, draws from the singular institutional framework established in close collaboration between the local university and the local business environment, mainly driven by the national telecommunication operator.

Following the launch of the first Digital Cities public funding program in Portugal (1998-2000), the municipality, the university and the incumbent operator set up a public-private partnership to develop the idea of Aveiro Digital City focusing on (a) quality of life in the city; (b) democratic participation; (c) extensive access to public and private digital information and services; (d) modernization of local public administration ; (e) inclusive development and sustainable growth; and (f) job creation and lifelong learning (Aveiro Digital City Coordination Team, 2001a,b; Municipality of Aveiro, 1998). The complete funding life cycle was expected to be 8 years, with the first phase of the project starting in February 1998 and lasting until December 2000, totaling an investment of 5,590,000 Euros. The second phase, originally planned to start in January 2001, has only begun on June 2003 and is planned to last until December 2006.

After a troubling start – negotiations over budget allocations and bureaucracy in both the formal approval procedures and the technical implementation schedule caused a lengthy delay of over a year – the first phase included 38 projects covering several different aspects of the use of information and communication technologies. Emphasis was given to infrastructures and digital contents, including local e-government, e-health, and e-business and entertainment, as amplified below.

Table 4
Main digital contents included in the first phase of the Aveiro Digital City Project

Intervention Areas	Activity
Digital Community	Facilitate internet access and active learning support in basic ICT to all citizens: 14 centers in local parishes, and 4 in disadvantaged neighborhoods.
Local Government and Public Services	Aveiro Municipality geographical and administrative information systems
	Water, sewage municipal services: one-stop shop
	Water quality sensing and monitoring system
	Internet and Intranet services for the Aveiro Judicial Court;
Schools and the School Community	Construction of communities involved in education, through training and facilitating communication between families, teachers and students.
	Pedagogical Games and Interactive learning applications for children to play, learn and communicate
University and academic community	Online biology competence centre in the areas of vegetal and animal diversity, molecular biology, local biodiversity and the Aveiro estuary ecosystem
Health Services	Intranet and Internet services for the D. Pedro V District Hospital and the 20 health centers functionally dependent of this Hospital, complemented with ICT training of health professionals
Social Solidarity	Computers, Internet access, ICT training, focused online information and services and design and validation of telework models for people with special needs
Economic Sector	Computers, Internet access and ICT training for 20 SMEs, including basic digital services provisioning
	Sea harbor telecommunication infrastructure, commercialization and management information systems. Integrated online services serving various communities
	eCommerce service centre (Internet and public access Kiosks) for local shops
	On-line shopping mall
	Cattle farming sector internet and intranet services for online management, involving 36 farms, with a national expansion
	E-Learning and interactive professional training
Culture and leisure	Interactive Pay-Per-View Pilot Project
	Online edition and publication of news and Internet radio broadcast
	Equipment, training for the production of digital art
	Interactive and pedagogical learning of classical music for all ages
	7 Public access information kiosks (City guides)
	History, culture, art and nature from Aveiro

Source: <http://www.aveiro-digital.pt>

E-business and education related activities accounted for 35.1% of the total number of approved projects and 40.7% of the budget allocated. E-government used up to 20.4% of the available funds. University-based and e-health projects included only two projects and utilized less than 9% of the total budget. On the other hand, projects involving entertainment, culture and the arts accounted for about 30% of the total number of approved projects, although they only received about 8% of the total budget available.

In general, ICT infrastructure – computers, applications, Internet access and basic ICT training – was the most important component of all projects, while investments in activities oriented towards mobilization of the population for the information society were practically nonexistent. Consequently, the evaluation of many activities demonstrated lower levels of public participation than planned, with some of the initiatives falling short of their original objectives (Aveiro Digital City Coordination Team, 2001a,b). E-government and other projects involving basic and secondary schools had more permanent effects, while e-commerce and e-health performed poorly. Budget cuts and uneven financing flows during the implementation phase posed extra difficulties and unnecessarily increased risk.

During 1999-2000, Aveiro Digital City made available 446 personal computers to diverse public and private organizations, published 8 CD ROMs and 32 websites, supplied 73 interactive services, and trained 529 people. The number of Intranet and Extranet users exceeded 3,000 people in different public and private organizations and the Aveiro Digital City Website (<http://www.aveiro-digital.pt>) registered a monthly average of 4,700 visitors.

The major question raised by the local persons involved in the project has been consistently associated with the structure of public financing and the conditions for long term sustainability, mainly due to the fact that when the limited public funds dried up some of the projects came to a close, while others kept their presence in the Internet but were rarely updated. Moreover, the funding concentrated mostly on the inputs of a long range process, namely infrastructures, information systems and ephemeral content, giving little consideration to mobilizing the population at large. Yet, knowledge networks, especially related to basic education, continued to operate and provided the necessary technology infrastructure for social capital building and information exchange.

Aveiro Digital makes a very interesting case for the need to streamline the processes for the submission, approval and funding of projects. First, the excessive bureaucracy postponed the start of the projects more than a year in most cases. Then the total public funding agreed upon with the Portuguese Government was stretched too thin to fund all the projects approved by the coordination team. On average, the approved incentive was only 50% of the amount requested. The reimbursements were also often delayed. These three factors contributed to cash flow problems in most of the projects, and together with poor management in the early months they created a number of technical and operational difficulties.

After more than a year negotiating the continuation of the project with the Portuguese Government, Aveiro Digital City just entered its second phase. It now includes 11 municipalities. The number of projects has grown to 72, totaling 22,000,000 Euros in investment in community building, local e-government, education, e-health, social inclusion, e-business and digital entertainment (Aveiro Digital City Coordination Team, 2005).

CONCLUSIONS

In previous papers Moutinho and Heitor (2004, 2005) argued that knowledge networks as particular forms of communities of practice, interest or proximity are important drivers of larger communities of users and make both public administration and markets more effective, but that they require infrastructures, incentives and adequate institutional frameworks over time and across space. The analysis was built on the co-evolution of regional development and the endogenous process of technical change, namely in terms of the diffusion of ICT, where the territory is a basic infrastructure that justifies and invites the construction of several layers of information, above all the creation of communication infrastructures and well arranged digital contents within local contexts.

In Portugal, the development of digital cities and regions has become one of the centerpieces of national policies for the development of the information society, playing a critical role for the appropriation of information and communication technologies at the regional and local levels. Therefore, this program must be understood within the context of the increasing focus on national technological competitiveness, global productivity growth, and modernization of public administration. Such a context set the stage for a top-down, technologically deterministic approach that has been constantly challenged by the increasing territorial complexity and heterogeneity of uses, attitudes and skills at the local level.

Taking into account the evidence provided by some of the projects discussed above, namely those at Aveiro, the role of higher education institutions appears to be particularly important in fostering network activities, namely in the form of knowledge-based communities. Following the analysis of Castells and Hall (1994), "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 the 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 the generators of an advanced technological milieu. Again, this brings our attention to the role of institutions in planning digital cities and promoting their impact.

Also, against the background of the conditions described above it is clear that market mechanisms do not necessarily work at the level of the issues associated with digital cities, namely the promotion of less favorable zones. At least in the early stages of their development, digital cities require an effective mix of public and private support mechanisms in a long-term perspective, taking

into consideration specific regional and thematic aspects. Moreover, digital cities may not be sustainable if promoted independently of a regional innovation system.

As a result, Conceição et al. (2003) have called our attention to the fact 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”. In principle, these shortcomings in 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 (Chandler and Hikino, 1996; Lundvall and Johnson, 1994). But government intervention must balance the potential distortions on competition that may result from intervention with the needs to “correct market failures”: artificial restraints on competition can also divert profits to activities other than building technological capabilities.

However, incentives and infrastructures do not operate in a vacuum, being shaped by and in turn shaping the particular context in which they operate. In the scope of this analysis, the city or region must have an embedded 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 the many different situations which prevail throughout the world, as acknowledged by Castells (2001), among others, and the analysis of the projects earlier considered shows that specific measures to promote adequate contexts have also been scarce.

The evidence demonstrates the need to extend the design of digital cities from a technocratic paradigm of technical change and to look at broader system designs fostering societal developments. In particular, the experience of projects such as Aveiro Digital City shows the importance of mutual relationships that specific project-based communities have on the facilitation of network societies, as well as the fact that the implementation of digital cities may significantly improve the efficiency of those communities.

The complex technology-enabled infrastructures typical of digital cities call for the integration of social and cultural factors in the early design phases in order to mitigate uncertainties, such as sustainability, flexibility and scalability. Moreover, digital cities may develop other unexpected properties, or emergent properties “developed by users of a system” and “often unbeknown to the system designer” (Moses, 2004). This being so, the stakeholders involved in the co-evolution of urban areas and ICT would be better off if, as proposed by Cooley (2000), “the current mechanistic paradigm of technological and societal development [would be substituted by] human-centered systems [that would] provide a powerful alternative philosophy for system design and a broader educational and societal development”. He adds that “[this philosophy] regards the social and cultural shaping of technology as central to the design and

development of future technological systems and society as a whole”, in terms of “knowledge-based adaptive human-centered environments” (Cooley, 2000).

Table 5
Emerging trends for a new generation of “Digital Cities”

Layer of Analysis	From	To	Implications and requirements
Institutions and Incentives	Centrally designed programs	Open public / private partnerships	Embedding ICT infrastructures in urban daily life, fostering human-centered systems
	Fixed access	Roaming	Competitive mobile services and improved regulatory framework for increased individual participation
Infrastructure and technologies	Conspicuous objects	Invisible infrastructure	Embedding ICT infrastructures in urban daily life, fostering human-centered systems
	Fixed access	Roaming	Competitive mobile services and improved regulatory framework for increased individual participation
Content and Tools	One-way distribution of information	On-line collaboration and participation	Specific knowledge of institutional and local contexts in order to help develop interactive contents
	Web functionalities	Networked Activities	New competences in content and services development, enhancing user activities and networks
Human and Social Context	Technology supply	Mobilization of users	Mobilizing “change agents” to foster communities of practice, CoP’s, and user involvement
	Standards	Interoperability	Building individual and social competences through knowledge-based adaptive human centered environments

In expanding this conceptual framework to the entire city or even whole regions in order to consider the way millions of people interact with information and communication technologies in their daily life, it is clear that the initial approach to designing digital cities described above needs to be reconsidered. Table 5 illustrates the main implications and requirements of emerging trends, so that the vast majority of potential late adopters are inclusively considered in future digital city projects. As Dertouzos (2001) argues, we can avoid “drowning in information overload and computer complexity only by throwing out last century’s model for computing and adopting – indeed, demanding – a new

computing philosophy, a new master plan, that lets people interact naturally, easily, and purposefully with each other and the surrounding physical world”. And he adds that “to put it in action requires three big steps: changing the mindset of users and designers; ensuring that our machines are easier to use and make us more productive; and insisting that new technology reach many more people”.

Table 6
The 10 main recommendations for the development of a new generation of digital cities

1.	New financial mechanisms and simpler administrative procedures must be created at the central level to decrease transaction costs and cope with accelerated technological change and the emergent properties of complex systems;
2.	Digital city programmes must be decentralized and focused on fostering public-private partnerships at local or regional level;
3.	The provision of competitive telecommunication services and an improved regulatory framework is a critical success factor for the deployment of public networks;
4.	ICT infrastructures must be embedded in urban daily life, fostering human-centered systems that respond to specific needs and desires;
5.	Project managers must develop an ongoing dialogue with local civic society and accommodate their needs and desires;
6.	Projects managers should also evaluate and eventually accommodate or mitigate emergent properties of digital cities;
7.	Inclusion of specific knowledge of local contexts is required in order to facilitate the development of relevant and useful contents and the strengthening of social networks;
8.	Identification and mobilization of local change agents is necessary to foster communities of practice, interest or proximity;
9.	The evolution from one-way distribution of information or two-way transaction (e-government) to real time collaboration and participation in local governance (e-democracy);
10.	Promotion of diversity and inclusiveness.

This analysis led to the suggestion that while the role of public policy needs to be re-examined (see the recommendations in Table 6), the cultural and social shaping of information technologies requires the specific development of human-centered systems designed to support community building activities (“edge to core” strategies) for the next generation of digital cities.

The reflections listed above were based on the need to take into account the uncertainty in the mobilization of ICT, which requires individuals, firms and organizations to operate in dynamic environments, where markets and technology change rapidly and in unpredictable ways. This calls for the need to combine flexible infrastructures and adequate incentives with institutions which will foster the necessary context for digital cities to succeed. The new paradigm of semantic grids can help ICT complexity to be alleviated and become an invisible infrastructure embedded in urban daily life.

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