Sylvie Occelli

ICTs, spatial analysis and socio technical systems: some evidence from regional case studies

Keywords: *Information and Communication Technologies; Socio-technical Systems; Territorial Organisations.*

JEL codes: *033 Technological Change: Choices and Consequences.*

Settori ERC: *SH2_13 Social Studies of Science and Technology, S&T Policies, Science and Society; SH3_4 Geographical Information Systems, Cartography; SH3_6 Spatial and Regional Planning.*

Sommario: *Le tecnologie di comunicazione e di informazione (le ICT) stanno creando un nuovo spazio per gli insediamenti e le organizzazioni umane, caratterizzato dal fatto essere costituito da un'infrastrutturazione informativa capillarmente diffusa. Tale spazio genera (favorisce) le condizioni di innovazione nelle funzionalità sistemiche, delle organizzazioni e dei territori. Queste infatti derivano dalle componenti intrinseche di innovazione associate alle ICT: quella hard, costituita dalle infrastrutture e dagli artefatti tecnologici veri e proprie e quella soft, che rispecchia la parte intangibile, associata alle conoscenze ed ai processi di apprendimento.*

Da oltre tre decenni, le modificazioni indotte dalle ICT sono oggetto di riflessione (anche) nel campo della geografia e nelle scienze regionali, anche se i cambiamenti in corso sollevano interrogativi inediti. Da un lato, gli impatti delle ICT che si osservano nelle organizzazioni ai diversi livelli territoriali, sono molteplici, diversi, e producono ricadute anche inattese sulle pratiche sociali. Dall'altro, gli utilizzi delle ICT modificano i modi attraverso i quali gli individui (e le attività) percepiscono, interpretano e si muovono nel loro ambiente, ciò che stimola una revisione critica dei presupposti stessi che stanno alla base degli approcci convenzionalmente usati nel concepire e analizzare le relazioni/interazioni con l'ambiente. Sulla base dei risultati delle attività di ricerca condotte dall'Ires negli ultimi cinque anni, questo testo argomenta l'opportunità di affrontare questa revisione. E lo fa da due diversi punti di vista, quello dell'analisi della diffusione delle ICT, condotta nell'ambito delle attività dell'Osservatorio delle ICT del Piemonte e quella del monitoraggio dell'incidentalità stradale, realizzato dal centro regionale competente. Un risultato generale, ed in parte inaspettato, della riflessione condotta è che l'approfondimento analitico delle ricadute delle ICT richiede di considerare, in modo non disgiunto, due esigenze apparentemente contrastanti: (ri) concettualizzare gli spazi geografici nell'era dell'informazione, apprezzare meglio l'importanza dell'ancoraggio territoriale dei fenomeni.

Abstract: *Today Information and Communication Technologies (ICTs) make it available a novel superimposing environment, i.e. an information wired environment, which concocts innovative system functionalities. These stem from the components of innovativeness underlying ICTs, and notably, the hard component associated with its tangible part, notably the technological artifacts and infrastructure and the soft component reflecting the intangible part, notably the knowledge asset and learning processes.*

Over the last three decades, the topics have challenged (also) geographical analysis and regional studies although today they appear even more challenging. On the one hand, the changes ICTs produce in human organizations at different spatial levels are diversified, manifold and increasingly affect social practices in unanticipated ways. On the other one, ICT usages modify the ways individuals and activities perceive, understand and move in their environment, thus prompting a need to rethink the premises on which they are conceptualized and studied.

This note is a contribution in this respect. Building upon the ICT research activities carried out at Ires over the last five years it aims to provide some arguments about the opportunity to undertake this thinking. As they involve different perspectives of analysis, - the regional ICT observatory and road safety monitoring - these activities provide interesting vantage points from which addressing the issues.

A main, and to some extent unexpected, implication exposed by the discussion is that ICT usages call for deeper insights into apparently opposite research directions. While they stimulate novel thinking about how to conceptualize geographical spaces in the information era, they also urge to reinforce the appreciation local geographic based phenomena.

1. Introduction

In everyday life, Information and Communication Technologies (ICTs) and Internet access are progressively transforming the ways people gather information about their surrounding environment and interact with it (Horrigan and Rainie, 2002, Dodge and Kitchen, 2004, Welmann and Haythornthwaite eds., 2002, Wilson and Corey eds., 2000).

As "urbanization is the very embodiment of

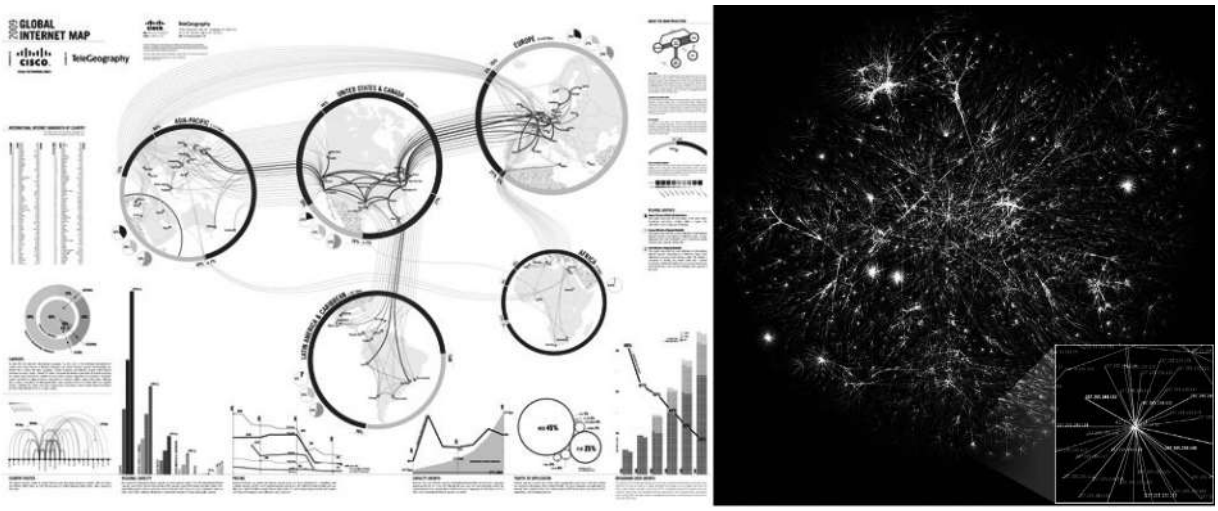

Fig. 1. Internet maps. *Source*: www.teleogeography.com.
Source: http://upload.wikimedia.org/wikipedia/commons/d/d2/Internet_map_1024.jpg.

communication" (Janelle, 1995, p. 408), cities as directly exposed to the impact of ICTs. They alter the distance limits prescribed by social practices, thus allowing for higher degree of accessibility. They are also time-adjusting as the time used in an activity can be freed for alternative ones. These features have also an impact on activities which can be more easily segmented in tasks and spread out across space and in time (Couclelis, 2009), although their effects are not easily accountable.

The maps shown in Fig. 1 give an overview of the spatial deployment of the Internet. They offer only descriptive clues of a phenomenon, the transmission of information which so far has no fully satisfactory reference dimension of analysis.

Notwithstanding the difficulty to grasp the phenomena, in the late nineties, the idea to have a digital space which would combine which the existing geographic, spatial, and environmental spaces raised a lot of expectations (see Kwan, 2001, Townsend, 2001, Warf, 2001), although its consequences in the analysis of cities and regions, were only partially acknowledged (Graham and Marvin, 2001).

The speculative bubble of the dot.com in the early 2000, abated much of the earlier enthusiasm. Lately, however, the new generation of ICTs, and notably mobile communications and web 2.0 Internet based services, are producing, again, an upsurge of interest in the digital space as it is realized that it can be an extraordinary source of innovation for organizations and their environment.

ICTs, in fact, create the opportunity for an increasingly information rich environment capable of nurturing and growing new types of Socio Technical Systems (STS). A STS is a comprehensive entity encompassing human and technological elements, communicating and interacting (sometimes in a non-linear ways) by means of manifold social and technical networks. Although no supremacy is alleged by one type of network in shaping the resulting socio-technical system, each one plays a role as, ultimately, they must close the gap between social needs and technical performance, between what communities want and what the technology does (Withworth 2009b) [1].

Indeed, cities can be viewed as particular forms of STSs, or, at least, as main components of such systems, providing, furthermore, one of the environments where these systems would develop.

Being anchored to the spatial distribution of population and activities, the geography of the Internet actually overlaps, to a large extent, that of cities and places. As the spread of Internet and backbone networks primarily depend on their acceptance among regions, data about their diffusion provide information about new attributes of places. Many of the current empirical analyses of the Internet for regions and countries make wide use of this type of approach [2].

However, being something different from the physical, cultural and functional dimensions we are accustomed with, addressing the digital dimension of spatial phenomena requires, conceptually, to consider a supplementary descriptive stratum, which, ideally, would add to the already existing multi-strata analytic compound we conventionally use (Occelli, 2011). By making reference to a multilevel investigation perspective such as that suggested by Mesarovic, Macko and Takahara (1970), for

Tab. 1. Perspectives in dealing with system multi-level analysis (adapted from Mesarovic, Macko and Takahara, 1970).

Type of levels	Issues involved
A) level of description (description by strata)	selection of strata depends on the observer
B) level of decision-making (description by layers)	it deals with the functional hierarchy entailed in the choice process (search, selection/adaptation, evaluation)
C) level of organization (description by echelons)	it identifies how an organization is structured (elementary units and their arrangements)

example, this would entail to consider an additional descriptive stratum to those conventionally used in describing a spatial phenomenon, see what in Tab. 1. is indicated as A), level of description.

The point worth emphasizing here is that web information about places and online services affect both the capability of individuals' decision making and the ways activities organize themselves across space and time. For example, getting information about products on the Internet, for example, is likely to change the functional hierarchy of the choice process, (see, level B, in Tab. 1), thus giving priority to their evaluation before physically undertaking a search[3].

As the virtual becomes increasingly intermingled with the physical (see Calabrese, Kloeckl and Ratti, 2007), real-time mapping of dynamics of places, furthermore, becomes an instrument for their inhabitants to "instantly adjust" their actions, thus altering the context in which they act (see, level C in Tab. 1).

As was the case for the earlier generation of ICTs, the implications of these changes are far from being fully understood Acknowledging the lack of data is only a partial answer to the fact that there is a fundamental need to develop more satisfactory approaches for understanding how the relationships between virtual and physical spaces will shape the spatial organizations of human settlements, make our socio technical systems more resilient, and ultimately more sustainable (see Couclelis, 2009, Janelle and Gillespie, 2004, Crang, 2010).

Whether this need calls for an overall encompassing perspective, such as that stemming from a combination of the various perspectives shown in Tab. 1, or for a novel type of approach is an open question which raises challenging research issues (see Occelli and Staricco 2001, 2002, Occelli and Lanza, 2002, Occelli, 2008).

This note is a contribution to the discussion.

It builds upon ICT-oriented researches undertaken at Ires in the last five years. As they were undertaken within different research strategies, - the regional ICT observatory and road safety monitoring - the results of these researches provide interesting vantage points for discussion.

In the remainder of the text discussion develops as follows. First, an empirical investigation is presented which analyses a set of virtualised geographical places, at different spatial levels (regions and cities). Web-based data and a claim is made that their analysis can be valuable for providing new insights into the description of places.

Then attention is turned to a the establishment of a STS for delivering a more reliable information system about road crashes. The case study carried out in Piedmont is an example of how social agents and technology can co-evolve and mutually adapt thus reinforcing the regional system functionality to cope with road safety.

The final section presents some tentative conclusions. A main, and to some extent unexpected, implication exposed by the discussion is that ICT usages call for deeper insights into apparently opposite research directions. While they stimulate novel thinking about how to conceptualize geographical spaces in the information era, they also urge to reinforce the appreciation of local geographical based phenomena.

3. Cities and the Internet: an investigation of the positioning on the web

As widely accredited in geography, cities have an important role as centers for information exchange (Janelle, 1995). Not unexpectedly, proficiency with communications technology and access to global Internet backbone networks are main determinants for enhancing that role, as they can also have a relevant impact on the overall urban structure, reinforcing and/or altering the networks of cities (Townsend, 2001).

Building upon the stimuli provided by the researches undertaken as a part of the Piedmont ICT Observatory activities (Osservatorio ICT del Piemonte), here the idea is given additional insights and an attempt is made to investigate the *location of places* on the web. To carry out the analysis the data

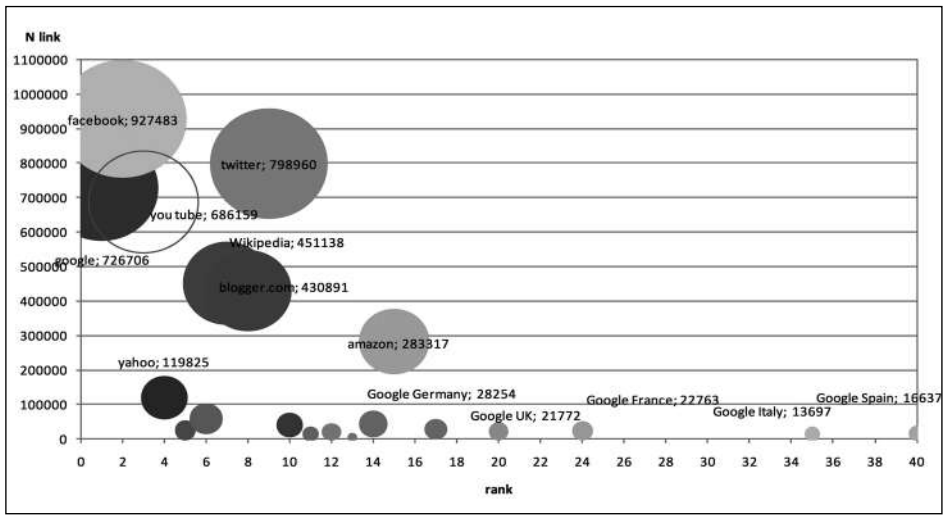

Fig. 2. The top 40 web sites in the world ranking, 2010 (Bubble size is proportional to the value of the reputation index). *Source*: www.alexa.com.

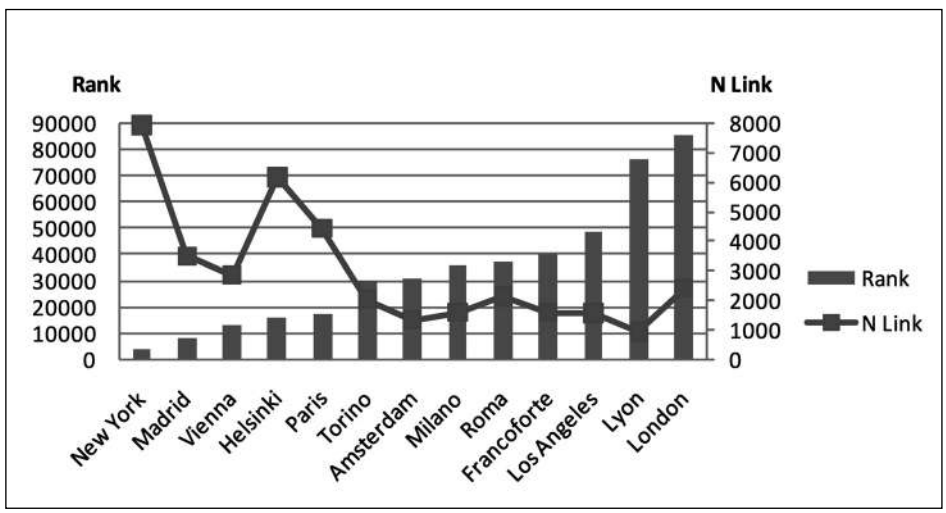

Fig. 3. Position of a sample of cities in the world ranking (Rank) and value of their reputation index (N Link), 2010 (The lower the rank the better the position is). *Source*: www.alexa.com.

obtained from a web information company (*alexa.com*) which provides statistics about the rankings and popularity of websites (Occelli, 2011).

More specifically we analyse a set of virtualised geographical places, represented by the institutional websites of Italian governmental bodies, at different spatial levels and compare their ordering with that obtained by using the conventional population indicator.

The ranking of a website is calculated using a combination of average daily visitors and page-views over the past 3 months. The website with the highest combination of visitors and page-views is ranked #1[4]. Two rankings are provided, one at a global level thus making it possible to position a website in an overall worldwide ranking and one at the level of the country which the website belongs to. Popularity, considered by *alexa* as a reputation index of a website, is expressed as the number of its inbound links[5].

Not unexpectedly, the most popular websites are by far those dealing with the Internet and concern web search and communication. As shown in Fig. 2, in fact, the top website, as for access and visited page is Google.

The most popular is Facebook, with a reputation index as high as 927423. YouTube is third and Wikipedia ranks in the seventh position.

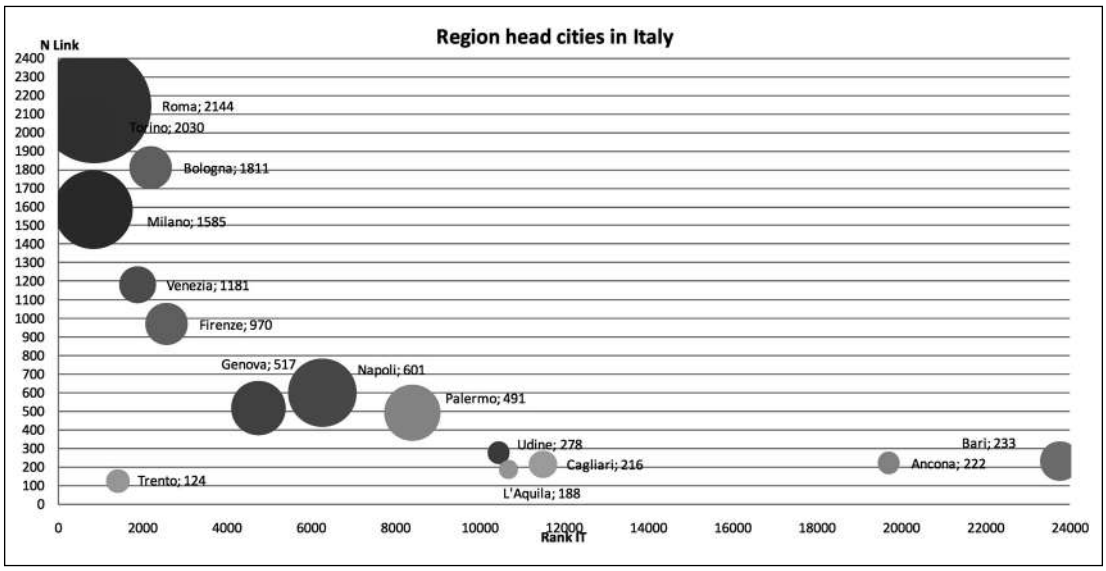

Fig. 4a. Website ranking (Rank IT) of regional head cities in Italy and value of their reputation index (N Link), 2010 (Bubble size is proportional to the city population. The 4 cities at the bottom of the ranking are not shown). *Source*: www.alexa.com.

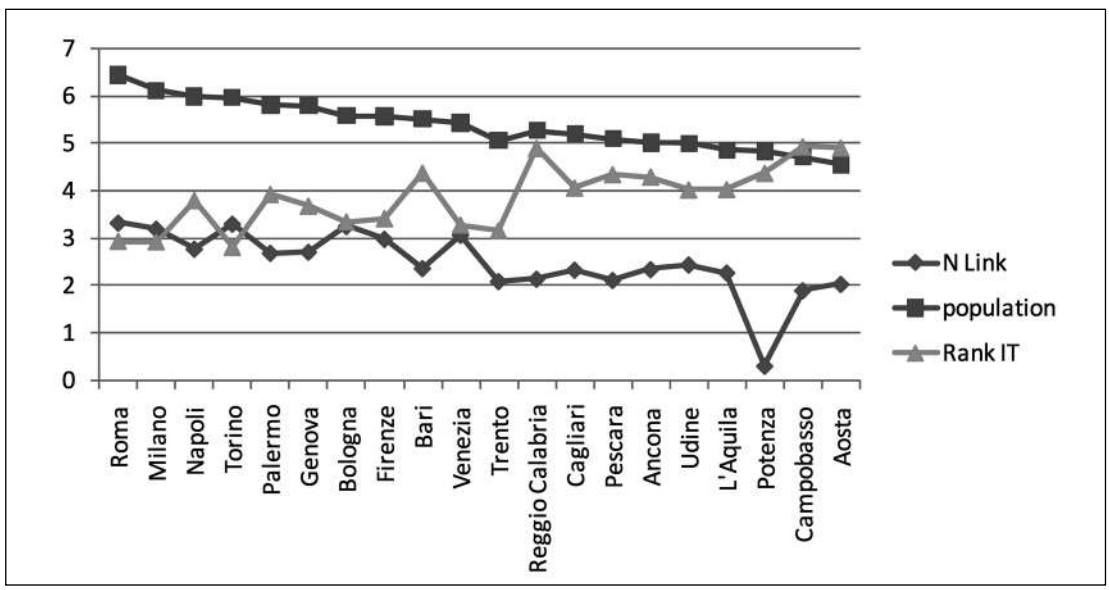

Fig. 4b. Standing of the Italian regional head city by population size, website rank (Rank IT) and reputation (N link), 2010 (Cities ordered by decreasing value of the population. All the indicator values have been log transformed).

The results of the investigation of the *alexa* information base for a sample of city governmental websites in Europe and United States are summarized in Fig. 3. They clearly show how far these virtualized cities are from the most popular Internet sites.

New York has the top position, followed by Madrid, Vienna, Helsinki and Paris. London ranks the lowest while the selected Italian cities (Turin, Milan and Rome) are situated in an intermediate position.

The value of city reputation index, however, does not parallel closely that of the city ranking. For example, although it ranks fourth, the city of Helsinki has the second best value of the city reputation index.

The graph in Fig. 4a shows the position of the Italian regional capital cities by their ranking value in Italy and value of the reputation index. Not unexpectedly, Rome, Turin and Milan, the most populated Italian cities are at the top: they all rank below the 2000th position. Rome and Turin have also the highest value of the reputation index. Milan how-

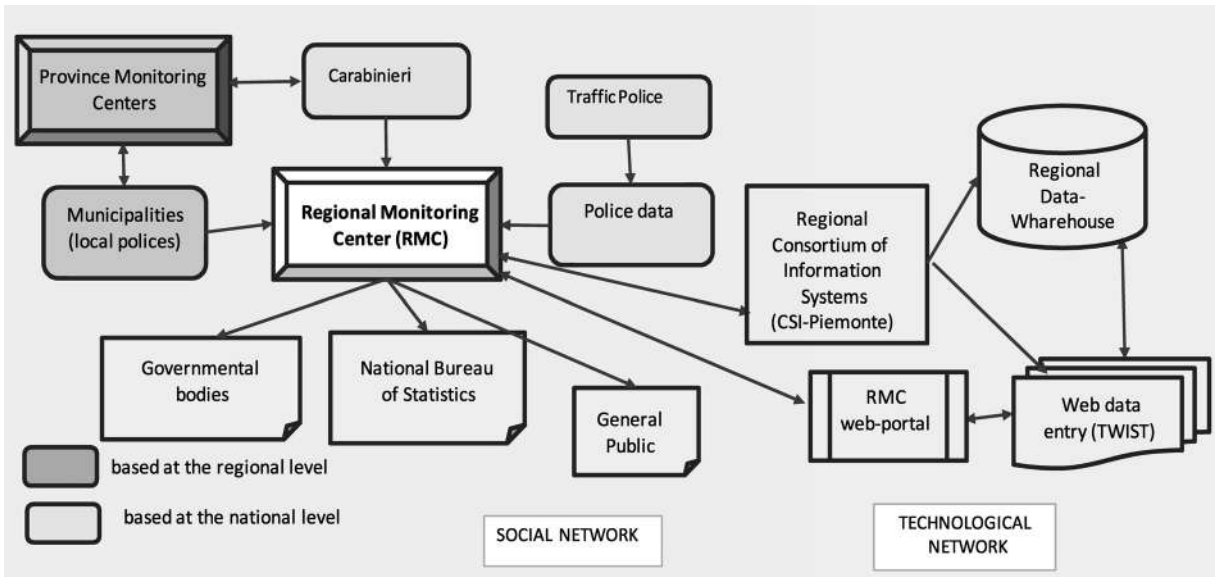

Fig. 5. The social and technological networks forming the STS for road safety monitoring in Piedmont.

ever is over classed by Bologna a city with less than half its population. Only five cities out of 20 have a value of the reputation index higher than 1000.

An overall overview of the city standing by population size, web ranking in Italy and reputation is shown in Fig. 4b.

As could be expected, there is a negative relationship between population size and web ranking: the more populated a city is, the better is its position in the web ranking.

A negative relationship also exists between ranking and reputation: a higher ranking is associated with a lower the reputation.

What is even more apparent, however, is that larger and more populated cities which also rank higher in the urban hierarchy of the physical world, are not necessarily those that are at the top position or have a better reputation index in the virtual world.

3. Developing a socio technical system for road safety monitoring in Piedmont

Because of the ICT increasing pervasiveness, designing and developing STSs are raising challenging research and policy issues as it is realized that some of their properties, and notably openness, learning and resilience, allow them to better cope with environmental complexity, innovative behaviour, new technology, and organizational transformations.

Today STSs networks, in fact, reveal unique features which distinguish them from previously existing ones (Berra and Occelli, 2009). This distinctiveness stems not only from the progress of ITCs and the many transformations occurring in social systems, but mainly from the knowledge flux instantiated by the interactions of ICT enabled nodes.

This concept is at the basis of a project undertaken by the Piedmont regional Transport Department to improve the information basis for the management of policy actions to contrast road crashes (Boero *et al.*, 2010). Its main purpose is to reinforce the capability/synergy of the agents' network involved in collecting road accident data.

The scheme in Fig. 5 shows the main agents involved in the social and technological networks making up the STS for road safety information. More specifically, the social network consists of:

- police departments, operating at municipal and national levels, who have the responsibility to gather the data of road crashes occurring on the Piedmont roads;
- the local monitoring centres supervising the data gathering activities at the sub-regional levels;
- the regional consortium of information systems (CSI-Piemonte) who sees to the development of the web software for entering road crash data (TWIST), manages the regional data-base and provides IT user assistance;
- the Regional Monitoring Centre (RMC) whose main assignment is to develop the STS and support its activities.

Although not directly involved in the data gather-

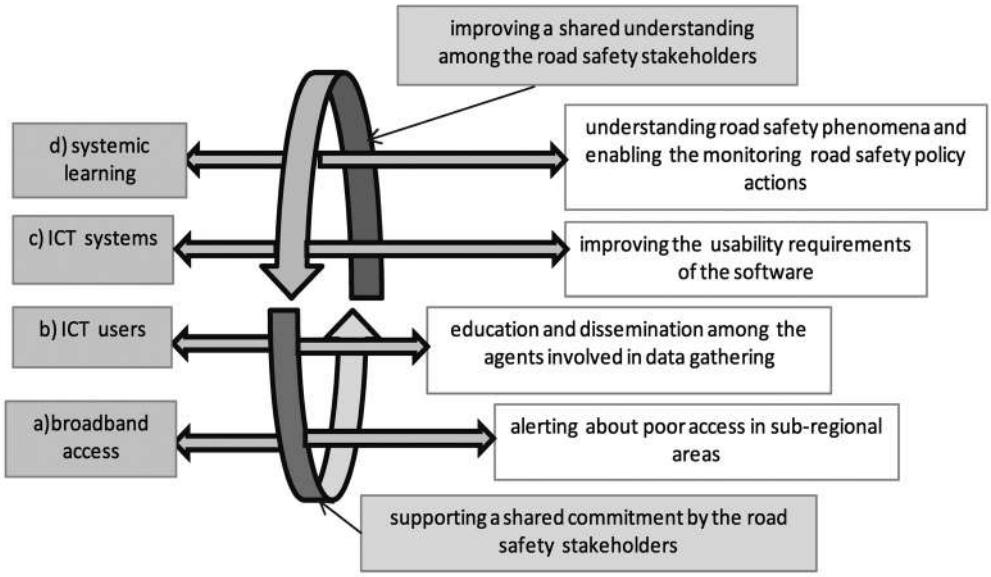

Fig. 6. Activities carried out by the RMC to support the STS developmental path.

ing, three additional classes have a role in the STS activities, as they can benefit from having reliable and timely information about road crashes, and notably: a) governmental bodies who have a direct responsibility in road safety initiatives and law enforcement. Among them, the regional Transport Department who provides financial support to the STS activities, the Health and the Regional Departments are main agents involved in the STS; b) the National Bureau of Statistics and c) the general public, as according to the e-government principles endorsed by the Piedmont e-government Plan, access to public information, should be provided to all citizens.

The STS technological network exploits the broadband infrastructure, recently deployed by the Piedmont regional government to boost regional competitiveness (see Wi-Pie.org). Actually, the whole design of the STS would not have been possible without that infrastructure.

Among the main nodes of the technological network, there are the web-data entry, the regional data warehouse and the regional web-site on road safety, managed by the Regional Monitoring Centre (RMC), providing access to statistical data, regional documents and best practices concerning road safety.

The development of the STS for road safety monitoring, takes inspiration from an conceptual framework which posits that an information wired environment results from the deployment of an innovation kernel (i.e. a systemic entity made up of ICTs, information and functionalities), operated upon by agents with reflexive and reflective capabilities (Occelli 2008).

The over-layered constructs making up the framework have identified as broadband access, ICT users, ICT application, and systemic learning (Occelli, 2011b).

As shown in Fig. 5, in the current organization of the STS for managing road safety in Piedmont, RMC plays a pivotal role. Its activities can be distinguished in two classes, see Fig. 6a) activities informed by the requirements associated with the different layers of the STS; and b) activities, which are transversal to the layers, as they are meant to favor a shared understanding of road safety issue, and stimulate a trustworthy engagement by the different road safety stakeholders.

Started in the late 2007, the STS has become fully operational in January 2009, when the software for data entering was. Currently, about 2200 users (more than 600 police departments) have subscribed to TWIST.

The Piedmont case study provides evidence of how a regional system or, at least, that part consisting of those agents concerned with road safety, was able to get hold of technology and use it to improve the system functionality of delivering more reliable information about road crashes.

It gives a signal, albeit a weak one, that by means of a STS an evolution in the conventional policy making is taking place. It shows that, eventually, information and, more specifically, a shared knowledge base are foundational for backing the policy activity over time.

4. Concluding remarks

ICTs are deeply affecting the environments where we live, although the transformations we observe are manifold, have no clearly defined patterns and since they are mostly qualitative they are also difficult to grasp.

In this paper two aspects of these transformations have been addressed.

The first deals with the possibility to investigate the position that places have on the web, as increasingly this is becoming the main communication platform for a multiplicity of diverse human and artificial agents.

Although by no means exhaustive, the analysis shows that the position on the web of a sample of cities, as represented by their institutional websites, does not necessarily match the one observed in the physical world. In this respect, one might argue, that the digital space is but another environment, where places and cities can compete as much as in the physical space. In fact "cities are located in this digital terrain as much as a physical one – one where flows of data and information have their own specific geographies produced through key cities and which in turn positions some (parts of) cities differentially in a global environment" (Crane, 2010, 327).

To investigate how cities situate themselves in the geography of the web and how the digital location can affect their position in the economic space and order is therefore worth being pursued in future research.

But it the second aspect, that related to how the digital and the physical dimensions of space mutually articulate themselves to produce new forms of human organizations (STSs) which turns out to be most challenging. They involve a purposeful and context meaningful co-evolution of both human and technological systems, both of which are geographically anchored (although the anchorage may occur at different scales, and over different time horizons) (Occelli, 2008).

The point is that this co-evolution is not a simple cause-effect process, but it is filtered, mediated and informed by the knowledge and learning capabilities individual agents and communities can leverage to support. In fact, "Humans try to marshal the agency of machines to serve their own purposes, but cannot always anticipate or control the consequences. Outcomes are emergent from the interaction of both forms of agency, not from one alone" (Rose, Jones, Trex, 2005, p. 147).

The Piedmont case study about the creation of a STS for road safety monitoring, offered an example of how favoring a shared understanding of road safety issue, and stimulating a trustworthy engagement by the different road safety stakeholders can provide such a leverage.

It shows that the operations of the STSs require to consider both the endo and exo-centric perspectives agents could embrace in engaging into the network relationships. Understanding the kind of knowledge and technological resources agents are endowed with and how these can be used for interacting and playing different roles is therefore worthwhile. Depending on how agents, as participants (the endo perspective) and/or observers (the exo perspective), would interpret the network's operations, different views of the STS can emerge (see the introductory arguments in sec. 1) and be instantiated as the STS progressively develops, and learns how to better develop.

Eventually, the arguments underlying the above aspects emphasize the mediation role of digital space for sharing knowledge, to be used for communicating and acting in physical space. But then, the challenges become how that role can help, in situated contexts, to imagine, manage and construct more sustainable physical systems.

References

Berra M., *Sociologia delle reti telematiche*, Bari, Laterza, 2007.

Berra M., Occelli S., *Governing Socio-Technical Networks. The Case of the Road Safety Regional Plan in Piedmont*, Paper presented at the AISRE Conference, Bari, and September 22-24, 2009.

Boero R., Grieco A., Montaldo C., Occelli S., Tarditi S., Un sistema informativo in azione: il caso di TWIST, in: Las Casas G., Pontrandolfi P., Murgante B (eds.), *Informatica e Pianificazione Urbana e Territoriale*, Atti della Sesta Conferenza Nazionale INPUT 2010, Vol. 1 Libria, Melfi, 2010, 15-36.

Calabrese F., Kloeckl K., Ratti C., *Wikicity: Connecting the Tangible and the Virtual Realm of a City*, GeoInformatics, 10, 2007, 8: 42-45.

Castells M., *Internet Galaxy*, Oxford, Oxford University Press, 2001.

Castells M., Informationalism, networks, and the network society: a theoretical blueprint, in: Castells M. (ed.), *The Network Society. A cross cultural perspective*, Northampton, Edward Elgar, 2004, 3-43.

Couclelis H., Rethinking time geography in the information age, *Environment and Planning* A, 41, 2009, 1556-1575.

Crang M., Cyberspace as the new public domain. In: Wanjiku Kihato C., Massoumi M., Ruble B.A., Garland A.M.(eds.), *Urban Diversity: Space, Culture, and Inclusive Pluralism in Cities Worldwide*, Baltimore, Johns Hopkins University. Woodrow Wilson International Center for Scholars, 2010, pp. 99-122.

Dodge M., Kitchen R.Code, *Space and everyday life*, London, WP 81, CASA,2004.

Ducatel K., Bogdanowicz M., Scapolo F., Leijten J., Burgelman J.-C., *Scenarios for ambient intelligence in 2010*, ISTAG, IPTS-Seville, 2001.

Fuchs C., *Transnational space and the 'network society'*, 21st Century Society, Vol. 2, No. 1, 2007, 49-78.

Graham S., Marvin S., *Splintering Urbanism*, London, Routledge, 2001.
Horrigan J.B., Rainie L., The Broadband Difference How online Americans' behavior changes with high-speed Internet connections at home, 2002, http://www.pewinternet.org/.
Janelle D.G., Metropolitan Expansion, Commuting, and Transportation, in: Hanson S.(ed.), *The Geography of Urban Transportation*, London, Guilford, 1995, 407-434.
Janelle D.G., Gillespie A., Space-Time Constructs for Linking Information and Communication Technologies with Issues, in Sustainable Transportation, *Transport Reviews*, 24, 6, 2004, 665-677.
Kwan M.-P., Cyberspatial cognition and individual access to information: the behavioural foundation of cybergeography, *Environment and Planning*, 28, 2001, 21-37.
Mesarovic M.D., Macko D., Takahara Y., *Theory of Hierarchical, Multilevel Systems*,New York, Academic Press, 1970.
Occelli S., New Information Technologies and the City: Rediscovering people and places, *Netcom, 15*, 3-4, 2001, 207-230.
Occelli S., Digital communities as collective agents of urban systems. Some evidence for the Turin Metropolitan Area, *NETCOM*, vol. 19, n. 3, 2005,79-100.
Occelli S., Probing an Information Wired Environment in Italy's Piedmont Region, Journal of Urban Technology, 15, 2,2008, 95-114.
Occelli S., Internet diffusion in Piedmont in the mid 2000, Paper presented at the XXX AISRE Conference, Firenze, September 8-10, 2009.
Occelli S., An analysis of cities and regions on the web: beyond multilevel approach? 17ième journées de Rochebrune: Rencontres interdisciplinaires sur les systèmes complexes, naturels et artificiels, Mégève, 17-22 Janvier, 2011a.
Occelli S., Monitoring road safety in an information wired environment: the case of Piedmont, Paper presented at the International Geographical Union Commission on the Geography of Global Information Society Heritage, Planning and eParticipation: The Evolving Forms of Information Society, Athens, July 3-6, 2011b.
Occelli S., Lanza C.,Tra Cyber-spazio e cyber-luoghi: verso una nuova organizzazione del sistema urbano. Il caso del sistema urbano di Torino, Atti della XXIII Conferenza AISRE, Reggio Calabria, 9-12 ottobre, 2002.
Occelli S., Sciullo A., Un'analisi del posizionamento dei territori sul web, Relazione presentata alla XXXII Conferenza Italiana di Scienze Regionali, Torino, 15-17 Settembre, 2011.
Occelli S., Staricco L., *Nuove tecnologie di informazione e di comunicazione e la città. Elementi di riflessione*, Milano, Angeli, 2001.
Occelli S., Staricco L., Prospettive aperte dalle nuove tecnologie di informazione e di comunicazione per una città diramata,in Bertuglia C.S., Stanghellini A., Staricco L. (a cura di) *La diffusione urbana: tendenze attuali, scenari futuri*, Milano, Angeli, 2002, 257-275.
Osservatorio ICT del Piemonte, Le ICT nella costruzione della Società del Piemonte, Ires, 2009, www.sistemapiemonte/innovazionetecnologia/osservatorioICT.
Rose J., Jones M., Trex D., Socio-Theoretic Accounts of IS: The problem of Agency, *Scandinavian Journal of Information System*, 17, 1, 2005, 133-152.
SCF Associated Ltd, A Green Knowledge Society. An ICT policy agenda to 2015 for Europe's future knowledge society, Bucks, UK, 2009.
Townsend A.M., Network Cities and the Global Structure of the Internet, *American Behavioral Scientist*, 44, 10, 2001, 1697-1716.
Warf B., Segueways into cyberspace: multiplr geographies of the digital divide, *Environment and Planning*, 28, 2001, 3-19.
Welmann B., Haythornthwaite C. (eds.), *The Internet in Everyday Life*, Oxford, Blackwell, 2002.
Wilson M.I., Corey K.E. (eds.), *Information Tectonics*, New York, Wiley, 2000.
Wi-Pie, www.wi-pie.org.
Whitworth B., A brief introduction to socio-technical systems, Encyclopedia of Information Science and Technology, Second ed, Ed Claude Ghaoui, Idea Group Publishing, Hershey, 2009a, 394-400.
Whitworth B., The Social Requirements of Technical Systems, in: Whitworth B and De Moor A (eds.), *Handbook of Research on Socio-Technical Design and Social Networking Systems*, PA, Hershey, 2009b, 3-22.

Notes

[1] Originally introduced in the fifties, the concept of Socio-Technical System (STS) has been progressively refined since then as computing and human requirements evolved. Today several definitions exist in the literature (see Berra 2007, Castells, 2001, 2004, Withworth 2009a), although they all share the general idea mentioned in the text.

[2] Data about Internet take up and on-line services, in fact, are generally translated into indicators and aligned with other socio-economic, environmental or spatial attributes for measuring the relative importance of places (cities, regions and countries). They are also used as proxies to probe the diffusion processes of technological innovation in large human organizations, such as local areas (see, Occelli, 2009, Osservatorio ICT del Piemonte, 2009).

[3] The decision complexity is an important issue in the organization of the STS. Agents' intentionality is probably the main property motivating agents to join a network. For human agents, in particular, the properties of reflexivity, i.e. self-awareness, evaluative capabilities and the attribution of agency to others, are at the basis of their decision making process. The communication possibilities enabled by and within a socio-technical network enhance the reflexivity process. They permit in fact to better link the decision making functional steps (selection of the most satisfying alternative, learning and adaptation, and setting the performances and evaluation functions). A related question, which eventually calls for taking into account the C) level in Tab. 1, is how to establish and operate these relationships in order to improve the coordination among the various agents, while strengthening the co-ordinability (the governance) of the whole network. This has several implications both social, such as those dealing with the issues of deliberative democracy, and economic, such as those raised by the need to improve the network efficiency, and mainly to reduce the costs of the network functional interactions (i.e. the administrative costs).

[4] Website rankings are updated daily. The data presented here have been collected in the first week of October 2010.

[5] The reputation index is updated quarterly. A more detailed explanation of this source of data is in Occelli and Sciullo (2011).