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GOVERNING SOCIO-TECHNICAL NETWORKS. THE CASE OF THE ROAD SAFETY REGIONAL PLAN IN PIEDMONT.

Mariella BERRA[1], Sylvie OCCELLI[2]

[1] Dipartimento di Scienze Sociali, Università di Torino, Via Sant'Ottavio 50, Turin, Italy. Phone: +39-011-6702606, Fax:+39-011-6702612, E-mail: Mariella.Berra@unito.it.

[1] IRES - Istituto di Ricerche Economico Sociali del Piemonte, Via Nizza 18, 10125 Turin, Italy. Phone:+39-011-6666462, Fax:+39-011-6666469, E-mail: occelli@ires.piemonte.it.

ABSTRACT

Today socio-technical networks reveal unique features which distinguish them from previous ones. This distinctiveness stems not only from the dramatic development of Information Communication Technologies and the many transformations occurring in social systems, but also from the knowledge flux instantiated by the interactions of ICT enabled nodes. The pattern of this type of network, however, is not easily accountable. In fact, it reveals an intrinsic complexity which cannot be simply understood by means of aprioristically given schemes. Besides recalling the main approaches to socio-technical networks, this paper attempts to single out the main dimensions of this network. A conceptual framework is suggested which may serve as a reference for their empirical investigations, design and maintenance. To test its explanatory power, the proposed conceptual framework is referred to a regional project, which is currently being developed as part of the Road Safety Plan of Piedmont.

1. INTRODUCTION

Socio-technical networks have become an important principle of social organization. They are foundational to both communities and society. Their existence intrinsically depends on the type of artefacts made available at a certain stage of the technical progress and on the usages individuals are capable to instantiate by means of them. The operations of socio-technical networks, in fact, are embedded in historically leaden processes and bear the marks of the culture they belong to. Eventually, at the collective level, their establishment may bring forth an upgrading of existing system functionalities, thus increasing the ability of organizations to adapt to changes, and even generate novel ones. As a result they make it possible for individuals to undertake innovative behaviors. These networks, therefore, have a major responsibility in fostering socio-economic changes and structuring of human organizations.

In fact, current societal changes increasingly show that socio-technical networks have an extraordinary potential for boosting innovations both at an individual and systemic level.

Today socio-technical networks reveal unique features, which distinguish them from previously existing ones. This distinctiveness stems not only from the dramatic development of Information Communication Technologies and the many transformations occurring in social systems, but mainly from the knowledge flux instantiated by the interactions of ICT enabled nodes. The pattern of this type of network, however, is not easily accountable.

Despite this difficulty, however, developing a conceptual framework for ascertaining the main dimensions underlying their operations is worthwhile. This can be helpful both in the design of novel organizations and in empirical investigation, for disentangling the properties of specific networks.

The reminder of this paper is organized as follow. Section 2 discusses the distinctive features of today socio-technical networks by contrasting them with those characterizing the networks operating before the current transition to an information society. The main approaches to socio-technical network are also briefly recalled. Section 3 singles out a perspective, related to the constitutive components and organizing principles of socio-technical networks. Section 4 will test the explanatory power of the proposed conceptual framework to a regional project, which is currently being developed as part of the Road Safety Regional Plan of Piedmont. A summary of the main findings and some suggestions for future research conclude the paper .

2. AN OVERVIEW OF THE APPROACHES TO SOCIO-TECHNICAL NETWORKS

2.1 Distinctive feature of socio-technical networks

Although they have been extensively studied in the past above all in the sociological and organizational fields, to date no comprehensive account of these networks exists. It seems therefore

worthwhile emphasizing some of their distinctive features as these are being established by the current processes of social and technological development.

Our discussion has no claims of being exhaustive but aims to set up some working hypotheses by identifying the conceptual elements which characterize today socio-technical networks, compared with those of the past. An effort is also made to hint at the theoretical background which will be referred to in our subsequent analysis.

A socio-technical system can be understood as an organisational and cultural paradigm which, through technology, brings functional and relational elements together, making way for a plurality of organisations of social networks (Gallino, 2007). This is therefore a comprehensive entity encompassing human and technological elements, interacting together by means of various social and technical relationships. No supremacy exists by one type of network over the other in shaping the resulting socio-technical system, although each one can play a specific role as the whole network is progressively established and changed over time.

To grasp a few salient aspects of the novelty of today socio-technical networks, Table 1 lists some of their constitutive components, i.e. technical network, information system, social network and social actor, and contrasts their attributes as these manifested themselves in the past and may be probed in the present.

Although to time reference is explicitly referred to in our discussion, a significant marker between the past and the present is represented by the appearance of the Internet and the subsequent developments of the WEB, from WEB 1.0 to WEB 2.0 (Berners-Leee2001).

While before the Internet, the technical system did not integrate with social networks, but could be considered as being immersed in the latter, after its appearance the four components have become progressively more integrated in a circular and systemic way. On the one hand, the social actor has an increasing responsibility in operating upon the connections between the technical and social networks and integrating their links. On the other one, ICT progress by changing the shape and contents of the technological network makes it possible to develop a symbiotic relationship between social and technological networks while extending the action range of social actors.

Today, the technological network may be understood both as a means and contents. The availability of open architectures, the interoperability of systems, the convergence of means of communications (TVs, telephones and computers), P2P communications protocols, develop the growth of an integrated and intelligent production system and distribution of information and contents on a global scale. In addition, the Grid and ubiquitous technology offer the opportunity for the growth and the selection of information, implementing the web of different and innumerable sources available from all over the world. In the process of "informational communication" individuals and social networks become connected across a global space. Only today do technological networks operate over a field of action which is, at one and the same time, physical, real and virtual. The result is that ICTs and social relationships integrate fast through rapid processes of grouping and regrouping, giving rise to the explosion of social networking and social software such as Web 2.0 Berra,2007).

Table 1. *Some features distinguishing past and current socio-technical networks*

	Past	Present and future
Telecommunications infrastructure	Bounded technology local Limited coverage	Interoperability. Global and local Ubiquitous
Information system	Closed Community (main role of experts and technicians) Top down organization Overcast communications	Open Community (diffused production, distributed intelligence) Bottom up and top down organization Peer to peer communication
Social network	Local Limited visibility Bounded accessibility	Cosmopolitan Extended visibility Extensive and incremental accessibility
Social actor	Centred identity Constrained action User	Multiple identity Flexible action Diffuser

These changes also affect the way information and knowledge are produced. A major transformation can be observed in the scientific community where the invisible college underlying the exchanges among experts is progressively being substituted by a peer to peer communication model, (Crane,1972 and R.K.Merton,1973). Also in ordinary life, taking advantage of open-source architectures, peer to peer communications have a major role in supporting processes in which producers and consumers can be pooled (prosumers) (Berra and Meo,2006), allowing for the creation of virtual communities capable of nurturing and sharing information and knowledge (Wellman, 2003)

But ICTs have deeply affected the very nature of social networks, which pre-existed the technological networks. They, in fact, have amplified and transformed social networks. They have given visibility to social networks, made them more flexible and enabled their expansion, while improving their accessibility by removing some of existing time and space constraints. New organisational, political and economic set ups have been created. ICTs thus become key components and enablers of both globalized and localized practices among organizations, individuals and across markets (Castells,1996and Id., 2001). As a result, ICT based social networking has become a major principle of social organization.

Social actors have an increasingly active role in both global and local networks. Moving from a society bound up in little boxes (Wellman, 2002; Salaff and others,1996), see the left part of Tab. 1, to a networked society, social actors acquire novel capabilities of multiple linking. Being able to adopt both an ego-centric and exo-centric view of the network may greatly enhance actors'

awareness about the network configurations, while calling for ethical values to appreciate their assessment.

The outcomes at the societal level are far from being clearly detectable. In fact, as pointed by Manuel Castells (Castells,2004) t he current information society is marked by the simultaneously development of opposing tendencies, individualism and communitarism, and by the contradiction between globalisation and the fragmentation of the social actor.

A final remark relates to the context in which socio-technical networks are situated. Their borders are permeable while interactions are innumerable and cross different networks. The possibilities, therefore, of establishing strong and weak ties are extended (Granovetter,1995). In this regard, Wellman develops the concept of networked individualism, to denote the growth in individual's communications (Wellmannan and Haythornthwaite, 2002).However, connections through the Internet are not divorced from real contexts nor do they exclude face to face relations. Rather they increase the chance to contact friends, make acquaintances and meet strangers. Contact, interaction and exchange of resources in personal communications and work relations are made easier by the existence of weak and strong ties and make it possible to achieve new forms of power distribution among actors .

Considering characteristics of socio-technical networks and referring to theoretical studies and researches could offer a new insight for discussing organizational principles that underlie new sociotechnical system ad offer some instrument for their government.

2.2 Theoretical background

Literature of socio-technical networks is relatively recent and its theoretical background is still under construction. In the following some main contributions are mentioned, which however only partially cover the field of study.

Two main precursors, which can be referred to the left part of Tab. 1, are the theory of Socio Technical System (STS) as pioneered by the scholars at the Tavistock Institute in the sixties and the Social Construction Of Technology, (SCOT), also labelled as Social Shape of Technology (SST) approach developed in the nineties.

The former marked a turning point in the field of sociological studies of organisation. It brought about a move from the technological determinism which dominated the organisation of work, shifting the attention to the conditions of the human being (workers), to their motivations and capability of being active agents within the whole organization (Emery and Trist,1965).

The latter focused on the composition and re-composition of interactions between technology and society. In the construction and diffusion processes of technologies, attention should be paid at the effects that cultural norms, social relations and power had on knowledge and on the practices of technology production (Bijcker and Law,1992 and Bijcker, Huges and Pinch,1987). SCOT approaches showed that technologies are constructed not simply developed as mere applications of scientific discoveries. Furthermore, the users of technologies play an active role. As a result, the whole society is dependent upon both its subjects and technological artefacts. In addition, SCOT

represents a symbolic and explanatory approach to technological production and use, pointing to alternatives for professionals who design, implement, use or develop policies about technologies.
Two major legacies have been inherited from those studies that offer insights into the recursive nature of changes of technological artefacts as social complexity increases. One is that technologies are neither determined nor univocal but that they reflect the complexities of choices which underpin the structuring of society. The second made apparent that the very role of technology, and namely the transformative one, could be played by human actors as well (in this regard, for example, a teacher could be a technology!).
These contributions gave an essential stimulus to a whole field of studies which has been developing since the establishment of the Internet, see the right part of Tab. 1.Two main approaches can be mentioned, in this regard, the Actor Network Theory (ANT) and the Socio-Technical Interaction Network (STIN).
ICTs as socio-technical systems have been a central focus of ANT scholars in their theorizing on social system organizations (Callon, 1986; Callon, Law and Rip, 1969; Latour, 2006). Social networks are shaped by people together with their technologies. ANT considers humans, organizations and objects as agency. Consequently affiliations of individuals, groups and organizations entail the use of ICTs to varying degrees, giving rise to heterogeneous socio-technical actor-networks where the technical and the social are not separable. The key concept of heterogeneous network stems from this. While networks contain many dissimilar elements, all are crucial for the cohesiveness of the network. Another key tenet is the role of the intermediary, a hybrid actor which includes ICTs and people organization. This role is crucial in translating the actions and interests of one actor into the actions and interests of another, thereby aligning the network to enable collaboration and coordination (Akrick,1987; Tuomi, 2002). In fact, actors define one another through interactions with other actors often requiring the intervention of intermediaries.
These elements help to explain the formation of network levels phenomenon such as interactions between technologies, social actors and social network as agency and the mobilisation processes which take place especially in the initial stages of the development of a new project (see section 4).
The approach providing the most comprehensive framework for analysing socio-technical networks systems is the Socio-Technical Interaction Network (STIN) approach also known as Social Informatics (SI) (Kling, Rosenbaun and Hert, 1998; Meyer, 2006; Swyer and Tworth, 2006). It gives insights into the understanding of both scientific communications and collaborations, and the activities enhancing the sustainability of communications networks. The complex issues surrounding ICTs, their uses alongside emerging practices have been investigated in many researches. Implementing an interdisciplinary approach, capable of coping with the institutional and cultural contexts, and of dealing with the ICT design and uses has been studied. STIN considers the interaction between people, organizations, institutions and a range of technologies in rather intricate heterogeneous arrangements where what is social and what is technical cannot be readily isolated in practice. STIN stresses the idea of how ICTs are an important and pervasive component of socio-economic life. While building upon the main tenets of SCOT and ANT, STIN introduces additional

key concepts such as those related to: a) the idea of ICTs as interpretatively flexible, adaptive in use and evolving, b) the concept of the seamless web, continuously transforming; c) the ongoing diffusion of communities of practices and c) the idea that people are embedded in multiple social relationships.

3. ORGANIZING PRINCIPLES OF SOCIO-TECHNICAL NETWORKS

An information-wired-environment is the recipient of today socio-technical networks. It can be understood as an over-layered entity consisting of four interlinked constructs, i.e. technological convergence, network effects, system affordances and systemic learning (Occelli, 2007)

- Technological convergence. It relates to the capacity of a vast array of different types of modern technology to perform very similar tasks.
- Network effects. Originally introduced in the economic literature in the seventies, this notion relates to the positive effects which are yielded when more usage of a product (and typically of an ICT product) by any user increases the product's value for other users (and sometimes all users). These can be further distinguished in a) direct effects, i.e. a raise in usage leads to direct increases in value and b) indirect effects, i.e. increased usage of the product spawns the production of increasingly valuable complementary goods, and this adds up to the value of the original product.
- System affordance. In human cognition, hardly ever the relevant information is available in the agent's mind but need to be extracted from the environment or from a certain context situation. Information, in other words, is encoded in the material world, i.e. .in the technological networks, it is situated and embodied, in both digital artefacts and human agents and may be accessed by agents in certain situations. As a result, continuum of affordance types can, in principle, be identified according to the different degrees of external and internal representation (Zang and Patel ,2006)
- Systemic learning. The term is here used in a general way to indicate the adoption of a complexity approach in which complexity is a lever for action (Leydesdorff,2001) . Complexity, in fact, is not only an extraordinary recipe for exploiting the law of requisite variety (Ashby, 1956), but it is inherent to the fundamental human activity system underlying any human organizations. Systemic learning, therefore, is human specific as it bears on a distinctive trait of humans which is rooted in their reflexive ability to make sense of their living experience (Occelli, 2005; Pollone and Occelli, 2007).Within an information- wired- environment, systemic learning cannot exist but in relationships with its constitutive layers, i.e. technological convergence, network effects and system affordances[1].

The four interlinked constructions are the basis for emphasizing the organizing principles of socio-technical networks. Actually, this perspective is but an extension of the last mentioned component

[1] This type of knowledge can be the source of those kinds of intangible collective goods underpinning culture and norm which ultimately are at the basis of human organizations. It can also support new forms of social relationships and the establishment of hybrid types of communities, i.e. communities in which the network of relationships are based on both virtual and face-to-face contacts. From a spatial point-of-view, filtered knowledge can be associated with both dispersed and concentrated spatial patterns, but it is value laden as it aims at sustainable human settlements.

related to systemic learning. To some extent, it accounts for the agency features previously discussed in relation to agents' roles in sustaining the functioning of the network, as these stem from the reflexivity based properties agents are endowed with, and notably the cognitive and evaluative. Underlying systemic learning are two major dimensions related to the exercise of agency, see Fig. 1: a) a human centred knowledge dimension, whose extremes are delimited by notions of completely transferable information (explicit knowledge) and non transferable information (tacit knowledge); and b) a technology centred knowledge dimension, which contrasts a notion of deliverable digital information and one which may be accessed by the use of technological artefacts (computers, Internet, mobile phones etc.).

How these two dimensions are related and can co-evolve, while interacting with the others components of the information wired environment (technological artifacts, network externalities and system affordances) is one major challenging issue in structuring socio-technical networks, 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 , 2005, p. 147)

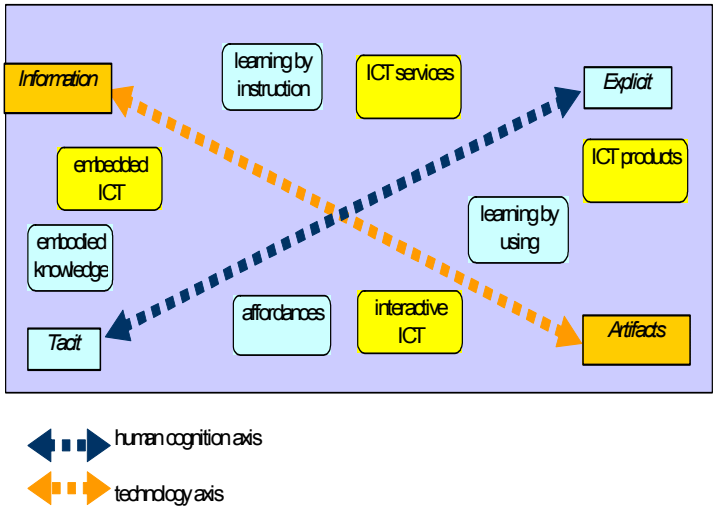

Figure 1. *An articulation of human and technology centred knowledge dimensions*

To address the challenge, the application of the constructs developed by multi-level system approaches may be helpful. In particular, we suggest that addressing the motivations calling for the very notion of levels would facilitate understanding (and designing) both the network structure and its functioning. These notions refer to the level of description, the level of decision-making and the level of organization.

As we have mentioned above whenever describing a socio-technical network it is necessary to identify the levels at which this would operate. The selection of strata depends on the observers and primarily on their points-of-view, as they may adopt an endo or an exo-centric views in engaging themselves into the network relationships. The functioning of today socio-technical networks calls

for both of them. In addition, it requires to articulate these views in relation to the integration of the human and technology agencies. Understanding the kind of knowledge and technological resources agents are endowed with, how they would interact among themselves, while playing and acquiring different roles as they may engage into communication by means of different, but increasingly convergent technological artefacts are crucial aspects in this respect. Depending on how agents, acting as both participants and observers, would interpret the network's operations different strata may be identified. These may be helpful for:

- defining the extension of the its action capability as the contexts in which the network operations are described on a different strata, are not in general mutually related (the principles and laws used to characterize them on any stratum cannot be generally derived from those used on other strata);
- getting awareness of the network functioning as its understanding increases by crossing the strata (in moving up the hierarchy, one obtains a deeper understanding of its significance, while in moving down a more detailed explanation).

One further articulation of socio-technical networks, concerns the level of decision complexity, the participating agents and the network agency would adopt in engaging into the network operations. Agents' internationality is probably the main property motivating agents to join a network (some sort of internationality can also be ascribed to technological agents). 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. Two main motivations underlying the latter are the need of acting without delay and of understanding a situation better, that is dealing with the uncertainties about the consequences of an alternative action.

The communication possibilities enabled by the socio-technical network provide a unique support for meeting these needs. They in fact make it possible to establish a number of feed-back relationships across the decision making functional hierarchy, consisting of the three-fold steps, selection of the most satisfying alternative, learning and adaptation, and setting the performances and evaluation functions. A crucial aspect in this respect deals with the ways of establishing and operating these relationships in order to improve the coordination of the various agents, while strengthening the coordinability or the governance of the whole network (Berra,2003; Coleman and Gotze,2001; Paradiso, 2003). 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).

One final articulation to be addressed in understanding socio-technical networks, relates to their pattern as this is structured by the type of mutual relationships established among the agents as interacting decision-making units.

The measures conventionally applied in network analysis, such as those assessing the centrality and closeness of the nodes, provide relevant clues in this respect.

4. AN APPLICATION OF THE FRAMEWORK IN CURRENT PRATICES

As a test of the explanatory power of the proposed conceptual framework, in the following reference is made to a regional project which is currently being developed as part of the Road Safety Plan of Piedmont. As elicited by the EU recommendations, the fundamental purpose of the project is to set up an updated road accidents data-base and a knowledge basis to support policy initiatives for reducing fatalities and promoting a greater awareness about road safety issues.

To realize the project a socio-technical network has to be instituted. It involves several types of agency, both human and technological. As for the former there are: a) the police departments, at the municipality, province and national levels, in charge of gathering the official statistics about the accidents occurring on the roads of all the (1206) municipalities; b) the local monitoring centres entitled with the promotion and coordination of the data gathering activities at sub-regional levels, c) the regional consortium of information systems (CSI-Piemonte) whose main tasks are to develop the data-entry software, manage the regional data-base and provide user assistance and d) the regional monitoring centre (CMRSS of Piedmont) which has an encompassing assignment to support the working of the network, by undertaking a number of research and communication activities and seeing to a few institutional duties (transmission of the collected information to the National Bureau of Statistic and evaluation of the planning initiatives concerning road safety). The technological agents are of two types: a) the software for data-entry and the regional web-site on road safety in Piedmont, containing different sections, covering statistical issues, documentation, best practices and education.

Neither the design nor the implementation of the network would have been possible without the current pace of ICT progress and the realization of the broadband program (Wi-Pie) launched by the regional government to build a modern telecommunication infrastructure in Piedmont and boost regional competitiveness []. Actually, the features of this socio-technical network are rooted in the components of the information-wired environment, as this is being shaped by the processes above mentioned.

Making reference to the constructs mentioned previously the following remarks can be put forward.

a) Technological convergence. This is being provided by a three layer-network, consisting of a: the regional backbone connecting the main towns of Piedmont (the province chief towns), the MAN networks to be built by the province local bodies and the local initiatives to be realized by the municipalities, mainly through wireless systems. Together, the different telecommunication networks will make it available a broadband access widely diffused all over the regional territory. This constitutes a fundamental requirement for accessing the data-entry software made available by the CSI-Piemonte.

b)Network externalities. Also as a result of the regional broadband program ICT adoption in Piedmont is increasing steadily among citizens, firms and local governments. To date about 60% of the municipalities have a broadband access. Although ICT usages are still modest, the uptakes are reaching a sufficiently critical mass to raise awareness in ICT potentials among the general public. This is an essential condition for the social acceptability of the role of the technological agents (the

web data-entry software and the regional web-site), and the maintenance of the socio-technical network functioning over time.

c) System affordances. A software for recording the data about road accidents through the web is being specifically implemented, building upon the experiences previously carried out in the region. Inspired by a web 2.0 logic, its design and implementation are a source of social affordances for the whole network as they create a means for a) purposively involving the various agents, thus strengthening the foundations for the network identity, and b) mobilizing and sharing agents knowledge and experience about collection and retrieval of road accident data.

d) Systemic learning. A central notion underlying the whole project is that road safety should be a shared responsibility among the various (human) agents involved in the Regional Road Safety Plan. This has several implications on designing how the knowledge and technology centred dimensions would be articulated. First, a great attention is being paid at making it available the relevant information about both the substantial and methodological issues concerning road crushes and their data (the representation levels). The regional monitoring centre has a primary responsibility in this respect as it has been entrusted with the role of supporting the learning process for the whole network. This responsibility also entails the managing of the regional web-site, which acts both as a repository of the collected information and as a means to make it widely accessible by all the agents (and the general public). The centre therefore is at the core of the network organization and has a major role in seeing to the setting of the performance and evaluation functions for the network operations. It plays therefore the role of what is called a supremal unit among the levels of the overall network configuration . Although institutionally endorsed, this role is tightly dependent on the activities of the various agents. The centre would not be able to perform its tasks if the other human and technological agents would not enrol in their own tasks.

The strategy for the development of the socio-technical network therefore is inspired by a need to apply what some authors have called a Socio-Technical Integration Pattern, to indicate a developmental path capable of enrolling both stakeholders and technology in an organisational and flexible way (Bendik, Nielsen and others, 2005)

5. CONCLUDING REMARKS

A main tenet of this paper is that a socio-technical network is a complex entity, that is an entity which cannot be reduced to its constituting components, notably the ICT and the social(actor) network. As recalled by our synthetic account of the existing approaches, both of them have been extensively enquired and the importance of treating them as coupled coevolving entities been recognized. It is only since the nineties, however, that this type of network has been conceptualized as intrinsically different from those well established, social and technological, networks scientists were accustomed to.

Eventually, the search for its distinguishing features has raised a challenge to develop novel approaches for identifying those network's properties likely to be generative of innovative organization patterns.

As widely argued in the social informatics field, in fact, acknowledging the intrinsic wholeness of this type of network, requires to go beyond a simple listing of attributes and calls for deeper insights into the joint social and technical processes generating and sustaining it.

This paper was meant to provide a contribution to this endeavour. Building upon some major findings of current researches, an effort was made to identify the main components and organizing principles of socio-technical networks. A conceptual framework was derived and applied for anlyzing and finding governance instrument of a regional policy in which the creation of a socio-technical network is an essential requirement for the policy actions.

Although far from being definitive, the results of the empirical exercise show that the conceptual framework may be a valuable support for detecting, otherwise not acknowledgeable, socio-technical networks. However, we realize that further insights are needed if such a framework should effectively underpin their construction and operation over time, in order to reach innovative and socially more viable societal organizations.

In this respect, in the following we suggest some issues that may be worth addressing in future research.

First, from a substantial point of view, there is a need to deepen the investigation :

- the type of processes by which humans and technology interact, depending upon the context in which these occur, thus making it explicit the operations of this type of networks which is still largely unrecognized;
- which type of outcomes of these processes are likely to emerge and how these are stabilized, thus enabling the transition towards novel organizational patterns;
- how certain selected outcomes are encoded into the societal organizations, thus making it possible the establishment of novel system functionalities, the yielding of novel societal norms and individual behaviours.

This calls for a research endeavour capable of combining theoretical thinking and field analysis, while catalysing different disciplinary domains, a challenge already raised in the field of social informatics.

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