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## Defining the regional innovation strategy for the year 2015: the case of the ITCE clusters in the North of Portugal

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**Abstract:** This paper describes the methodology and the definition of the regional innovation strategy, based on the Information Technology, Communications and Electronics (ITCE) clusters, for the North of Portugal under the project NORTINOV 2015, which was promoted by the commission for the coordination and regional development of the north of Portugal (CCDR-N) under the NORTINOV programme. Three strategic lines were proposed to achieve a regional innovation strategy for the ICTE cluster for the year 2015: the strategic line, in order to create conditions for the development of innovative clusters, the sustainability line, in order to facilitate the interaction with other clusters, and the structural line, in order to position the North region as a world-class region.

**Keywords:** prospective innovation; innovation systems; North of Portugal; information technologies; IT; communications; electronics.

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## 1 Introduction

Innovation has long been recognised as one of the main prerequisites of sustainable development of firms, regions and nations. More recently, innovations are recognised as the outcome of fruitful collaboration and interaction between business firms and a wide variety of institutional actors around them, in such a way that a systemic approach was put forward in order to identify and deal with all relevant actors (Carlsson et al., 2002; Cooke and Memedovic, 2003).

The literature on innovation systems can now be identified with different conceptualisations: National Innovation Systems (NISs) (Lundvall, 1992; Nelson, 1993; Porter, 1990), Regional Innovation Systems (RIS) (Cooke et al., 1997), Sectoral Innovation Systems (Breschi and Malerba, 1997; Malerba, 2002) and Technological Systems (Carlsson, 1995; Carlsson and Stankiewicz, 1995). Although these concepts have been used extensively, it is acknowledged that they have been hard to operationalise (Rondé and Hussler, 2005).

The importance of RIS stems from the increasing interaction of regional actors on the outcome of the innovation process. Although having a similar economic and industrial background, RIS are far from homogeneous (Heidenreich, 2004). In a similar vein Innovation Systems need to take into account different spatial and technological levels of their actors (Andersson and Karlsson, 2006; Arocena and Sutz, 2000).

Heidenreich (2004) argues that the importance of local experience-based, context-bound knowledge, of trust-based patterns of cooperation and the path dependent accumulation of competencies are crucial for a RIS to prosper. Heidenreich (2004) has also found that the governance structure of the RIS may, to some degree, limit the innovation process of the region. Finally, substantial differences are expected between large and small regions in economic performance and in the functioning of the RIS.

Taking into account that RIS stem from cooperation and the accumulation of path-dependent competencies, it is expected that small regions of less-favoured countries

with limited number of developed industries and with a historical governance structure with strong centralisation patterns to be naturally disadvantaged in terms of RIS.

As a *less-favoured economy* in the European context, Portugal has experienced a learning process dealing with the intricacies of increasing competition. Nevertheless, while some regions have managed to outperform the average national economic growth rates other regions have steadily declined. The Northern region, formerly dynamic and prosperous, has been losing power *vis-à-vis* to other Portuguese regions over the last two decades. This North region has relied heavily upon traditional industries such as footwear, textiles, cork and furniture, even though significant economic activity can also be found in more technology intensive clusters.

Can the North region develop a credible regional innovation strategy in spite of the absence of a strong pattern of decentralised innovation governance? What are the main challenges the region has to overcome? The abovementioned questions are crucial for small regions not only to overcome regional disparities in cooperation and knowledge creation and accumulation but also in the creation of decentralised infrastructural innovation governance.

In an effort to deploy innovation in the North region, the Commission for Coordination and Regional Development of the North of Portugal (CCDR-N), promoted during 2004 the project *NORTINOV 2015*, with the main goal of defining a regional innovation strategy for the North of Portugal pertaining to the Automotive, Information Technology, Communications and Electronics (ITCE) clusters for the year 2015. These clusters were chosen because they were considered to be a driving force in the development of business in the region. The Automotive cluster was selected as it is known to be an integrator of technologies and competencies. In contrast, the ITCE clusters were chosen as they are considered to be producers of technology with applicability to different sectors.

The CCDR-N based their choice on the search of a new engine of innovation and underpinned their decision on the cross-fertilisation effects of the Automotive (known as an integrator of technologies and competencies) and ITCE (known for their pervasive effects in other business sectors) clusters in order to spark off a new model of development of Portugal's Northern region.

This paper is partly the result of the authors' involvement in the *NORTINOV 2015* project, which included a foresight exercise involving the ITCE clusters. The purpose of this paper is two fold. Firstly, to present a summarised version of the regional innovation strategy of the ITCE clusters of the North of Portugal for the year 2015, resulting from the mentioned project. Secondly, to address the main challenges the North region faces to operationalise the defined regional innovation strategy, as Portugal's innovation governance is centrally coordinated by the Ministry of Economics that follows a sectoral approach. Accordingly, it is a case study relevant to a number of smaller countries/regions, lacking the diversified innovation infrastructure typical of larger/more developed regions, with homogeneous characteristics (population, languages, economy, etc.) attempting to close their gaps *vis-à-vis* technologically advanced countries/regions.

This paper has six different sections. After the introduction, which represents the first section, the paper is organised in the following way. In Section 2, the theoretical foundations of innovation systems are presented. Section 3 characterises the three clusters under analysis. The fourth section reports on the methodology followed in defining the RIS for the year 2015. The fifth section presents the RIS along with the

strategic lines and, finally, Section 6 provides the main challenges that lie ahead in terms of research and policy implications.

## 2 Innovation systems

The term NIS was first presented by Freeman (1987) in reference to the complexity and dynamics of the innovation process. Freeman (1987) defines NIS as a set of public and private institutions whose activities and interactions generate, import, change and diffuse new technologies.

For Lundvall (1992) an innovation system is composed of elements and relationships that interact in the production, diffusion and use of new knowledge. This innovation system includes a set of elements and aspects of the economic structure that affect the processes of learning, searching and exploiting new knowledge and involves six main vectors: the internal organisations of firms, the interfirm relationships, the public sector, the financial support system, the science and technology institutions and the education/training system. According to Caraça (1993) and Gregersen and Johnson (1996), although the core of the NIS is composed by firms, what is at stake is the quality and quantity of the interactions and interdependencies that are established among the six vectors.

Lundvall (1992) differentiated between *narrow* and *broad* innovation systems. The former approach identifies institutions that promote acquisition and dissemination of knowledge. The broad approach recognises that innovations can be generated in every part of an economy and that practical, cultural and economic differences may determine the sources of innovation.

The European Commission, the OECD and the United Nations Conference on Trade and Development (UNCTAD) have used the NIS concept as an analytical tool, which has led several researchers to apply it to regions and sectors. As a result of the growing number of articles, Edquist (1997) has put forward the concept of *Innovation Systems* based on the following features:

- innovation, intrinsically linked to learning, which is at the centre of the analysis
- its holistic and interdisciplinary perspective, as it comprises economic, institutional, organisational, social and political determinants
- its historical and path dependent perspective
- the lack of an optimal system
- the main role given to institutions and their linkages and to the flow of intellectual resources in the search of a new stable regional order
- the importance of interdependence among actors and the non-linearity of the innovation process, which play a key role in the process of creative destruction.

Edquist (1997) defends the relevance given to NIS based on the fact that it captures important aspects of the policy of the innovation process. Thus, a NIS addresses governmental policies of science, technology and innovation, R&D competencies of both public and private systems, educational systems and financial institutions.

Although the initial analysis of innovation systems has been applied to a national reality, the same analysis has been made on a regional basis giving rise to *RIS*

(Cooke et al., 1997). As stated by Cooke and Morgan (1998), NIS have been influenced by two different tendencies: globalisation and regionalisation. Therefore, and taking into account that some regions have managed to prosper more than others, those thriving regions can become important development centres given that the regional networks in which they perform are privileged factors for the establishment of trust relationships essential for the learning and innovation process.

The origin of the concept of RIS is based on two main bodies of research: one that conceptualises innovation as an evolutionary and social process and the other that tends to explain the socio-institutional environment where innovation emerges. As a consequence, innovation is stimulated and influenced by many actors and factors and innovation systems are characterised by cooperation between firms and other institutions.

Although a fair number of studies have been undertaken to characterise and/or explain the source and evolution of RIS (Asheim et al., 2003; Cooke et al., 2000, 2004; OECD, 2001; Oughton et al., 2002; Sternberg, 2000) a basic problem seems to persist in all types of studies involving RIS as it is not yet known how a RIS would look like in reality due to both the different capabilities and the different innovation potential of all actors of this RIS.

According to Wiig (1996) though a RIS should be analogously addressed as a NIS, one should bear in mind that regional institutions and actors may differ from the national standard and, consequently, should not be regarded as a micronational system. Radosevic (2000) is less institutional and contends that a RIS develops from interactions at different national, sectoral and region-specific levels. According to Asheim and Isaksen (2002), a RIS is constituted by two key actors: firms from a regional cluster and the regional institutional infrastructure composed of physical infrastructure, knowledge infrastructure and the financial support infrastructure. The key aspect for the RIS is that firms and institutions learn with each other as soon as they interact giving rise to tacit-based knowledge and specific knowledge spill-overs, which will lead to differences in regional development.

Knowledge spill-overs and knowledge transfers are of special importance to the innovation process. While the former are known for facilitating the informal diffusion of knowledge when firms are located close to each other, the latter normally involve a commercial transaction, which is a more explicit planned transmission of knowledge. In the case of a RIS, skills, routines, norms, mutual trust and socio-cultural homogeneity facilitate the transmission of tacit knowledge by locational and relational proximity of agents, which underpin knowledge spill-overs as well as knowledge transfers because it is easier to establish contacts and exchange information among regional actors than to external entities (Capello, 2001).

RIS and NIS are not all alike as they depend on the location and flow of knowledge between actors. Asheim and Isaksen (2002) have put forward three types of RIS:

- 1 the territorially embedded regional innovation networks
- 2 the regional networked innovation system
- 3 the regionalised NISs.

Geographical, social and cultural proximity plays an important role in the generation of firms' innovative activities in territorially embedded regional innovation networks. Learning-by-doing and learning-by-interacting are the main knowledge generating mechanisms as the presence and interaction with knowledge providers is relatively modest (Asheim and Isaksen, 2002). Although knowledge flows interactively among

actors, most of them networking Small- and Medium-Sized Enterprises (SMEs), the probability of producing radical innovations is low due to the modest presence of knowledge providers. As firms in territorially embedded regional innovation networks rely on locally developed knowledge, innovations achieved tend to be mainly incremental in nature due to the lack of strong knowledge providers.

The lack of cooperation with knowledge organisations in territorially embedded regional innovation networks may jeopardise the firms' ability to catch up with new technology. As a consequence, to remain competitive firms must develop external linkages in order to avoid lock-in situations.

In regional networked innovation systems the regional institutional infrastructure is more systemic than in territorially embedded regional innovation networks. This is achieved by means of a strengthened infrastructure with more R&D institutions, more vocational training and more higher education institutions (Asheim and Isaksen, 2002). As regional networked innovation systems are regarded as ideal-typical RIS, local firms have a higher probability of generating radical innovations than in the previous situation, which is the result of the strong networking activities of the regional cluster of firms. As a consequence, regional networked innovation systems can be seen as an extension of territorially embedded regional innovation networks, in which firms have access to more regional competencies, which in turn reduces the likelihood of lock-in situations and increases the profitability of radical innovations.

In regionalised NISs outside actors are involved in regional firms' innovative activities as well as in the regional industry as a whole. As a consequence, knowledge providers are located outside the region, which to some degree limits the innovation process of the region. The institutional infrastructure is in part integrated with the NIS.

Asheim and Isaksen (2002) point out that in regionalised NISs the interaction between knowledge organisations and the firms are more based on specific research work between knowledge providers outside the region and the local industry than on integration and continuous involvement of all actors. These types of cooperation are normally based on specific projects which seek radical innovations. This interaction is more based on commissioned research work than on continuous involvement. Therefore, though specific projects seek radical innovations, the model of innovation is rather linear in nature.

Governance of innovation has different peculiarities in different RIS. In territorially embedded networks it must recognise the importance of developing regional networks providers and/or the importance of linking the firms to external knowledge sources so that the model of innovation can evolve from the linear type to the interactive one and thus reducing the locked-in effect. In regional networked innovation systems it should aim at the development of the university-R&D institutions-industry collaborations so that radical innovations can be more easily generated. Finally, in regionalised NISs it should aim at the strengthening of regional absorption capability reemphasising the decentralisation of innovation support in order to encourage the transfer of learning opportunities from strong to less-favoured regional innovation system.

On a different vein Heidenreich (2004) introduced two types of RIS: the Entrepreneurial and the Institutional ones. While the latter are characterised by an industrial structure with a strong position of low and medium technology, a governance structure dominated by formal, in general public institutions and by a business structure characterised by an important role of multinational companies, the former is

characterised by a solid bed of strongly knowledge-based SMEs, creative entrepreneurs in new technological fields and by a strong position in knowledge intensive services.

Following a spatial, social, material and temporal dimension of regional innovation processes, Heidenreich (2004) addressed the different innovation dilemmas and regional governance of 15 regions. He put forward the four following dilemmas:

- firms must take advantage of local experience-based, context-bound knowledge to face world-wide oriented competition
- trust-based patterns of cooperation between actors (firms, schools, R&D institutions, authorities and users) must facilitate the recombination of technical knowledge and the embeddedness of new technologies
- the coupling of scientific, economic, political, technical and cultural actors in order to facilitate the reciprocal adjustment of perspectives and actions
- the accumulation and path-dependent development of competencies in order to (re)generate regional competitiveness.

For Heidenreich (2004) these dilemmas pose different challenges to innovation governance. In the case of *Grassroots* regions the main challenge is to overcome the highly fragile institutional order threatened by firms' individualistic behaviour and weak local authorities. In *Dirigiste* regions the main challenge is to overcome the stability of institutional order and to generate regional cooperation among actors. Finally, in *Networked* regions the main challenge for governance structures is to maintain entrepreneurial interests and to match regional R&D, technology transfer and economic policy to the new global challenges of the knowledge-based economy.

Clearly, the specificity, complexity and interdependence of different RIS depend on both the technological knowledge of actors and the type of innovation system governance.

### **3 Methodological steps for defining the regional innovation strategy**

The research methodology was developed by the NORTINOV 2015 project team and defined the approach and the activities undertaken in order to reach all the operational aims with all resources and deadlines.

This methodology involved the following actions (CCDRN, 2004a,b):

- The gathering of all available information, previous studies and diverse bibliography on the ITCE clusters as well as on quantitative approaches as the European Innovation Scoreboards about Portugal and the North Region. Most of the information gathered was scattered on several studies and was aggregated on a technical report (CCDRN, 2004a).
- A Benchmarking exercise with other regions of the ITCE clusters. Several regions were selected for a preliminary study, namely Catalonia, Galicia, Basque Country, Castilla-León, Île de France, Baden Wurtemberg, Chicago, Silicon Valley, Czech Republic, Hungary, Poland, Ireland and Finland. The main objective of this Benchmarking exercise was to understand the reasons of success of several regions as well as to position the North region *vis-à-vis*

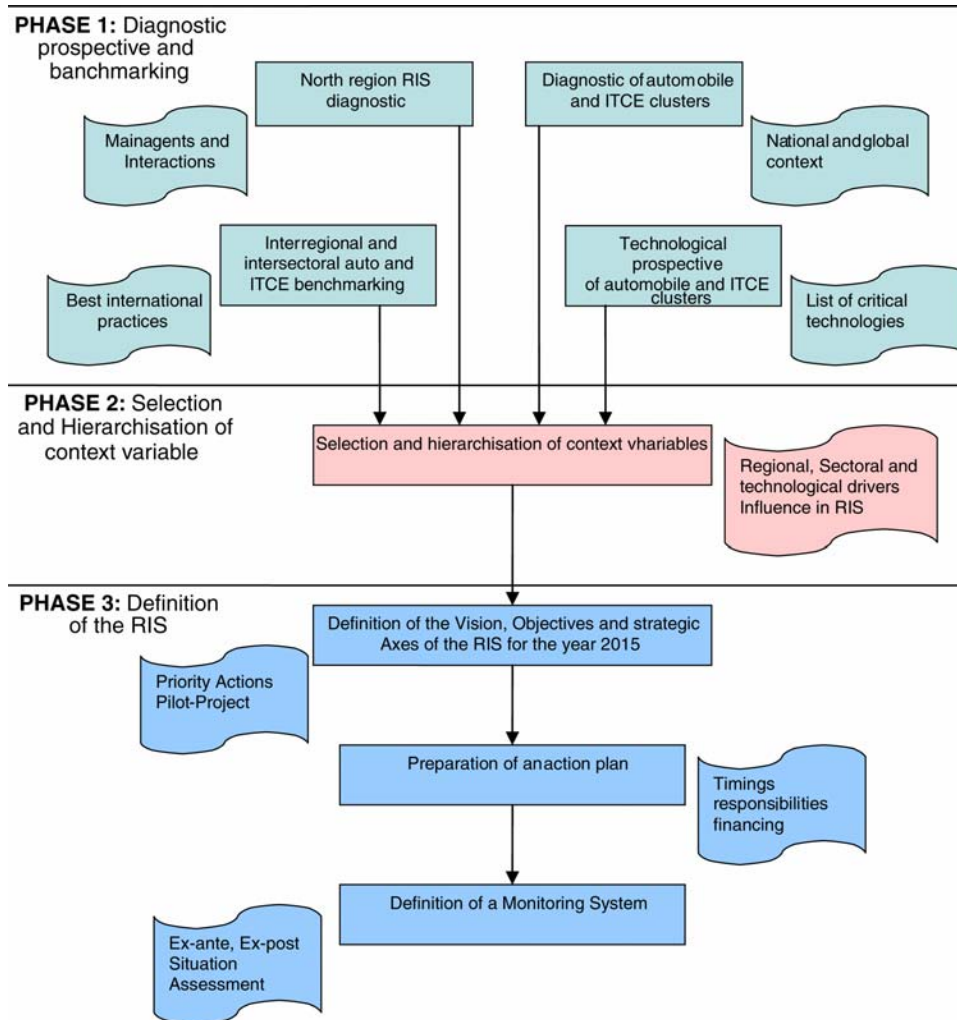
other regions. As a consequence the project team decided to benchmark the North region with Catalonia, Galicia, Île de France, Czech Republic and Ireland.

- The identification of critical technologies to attain a regional innovation strategy in 2015. It involved the identification of the main emerging technologies of the ITCE clusters, its refinement, in which a list of 90 emerging technologies were identified and, finally, its classification, in which 30 critical technologies were identified as critical for crafting the regional innovation strategy. This process involved the interviewing of national and international specialists and the organisation of working sessions with academicians and business specialists.
- The implementation of technological audits to relevant firms and RTD institutions in order to monitor how leading entities of the northern region were performing, what technologies they were using, what competencies they had lacked and they could find in the region, what types of R&D projects they were involved in, what strategies they defined and what the future perspectives looked like. These technological audits were conducted in 11 key companies and in 10 R&D institutions of the region.
- Interview with recognised specialists and opinion-makers to validate and complete the collected information.
- The assessment of the project by a group of external experts assuring that the project reached all their purposes.

The methodology is presented in Figure 1 and is divided according to the following stages and activities:

- 1st Stage prospective diagnosis and benchmarking
  - *A diagnosis of the RIS of the North*: which characterised the region and its main components and interactions.
  - *A diagnosis of the ITCE and auto industries*: where both industries are characterised taking as background the national and the global context.
  - *A prospective analysis of emerging technologies of the Auto and ITCE Industries*: which involved the forecast of the technologies for the year 2015 and its classification according to the regional reality aiming to detect the critical technologies for the development of the North region.
  - *An interregional and intersectoral benchmarking*: where the best international practices of innovating regions were selected for the competitiveness of the ITCE and Auto industries – Galicia and Catalonia (Spain), Czech Republic, Ireland and Île de France (France). General information, industrial structure, selected innovation strategies and governance were analysed and compared with the North of Portugal practices. The analysis was based on previous studies and interviews with key organisations in each of the selected regions.
- 2nd Stage: selection and hierarchisation of context variables
  - *The selection of context variables*: According to the results obtained in the previous phase and taking the benchmarking analysis as reference, the main regional, sectoral and technological drivers that would influence the RIS were selected.

**Figure 1** Methodological steps in the development of a regional innovation strategy



- 3rd Stage: definition of the regional innovation strategy
  - *The establishment of a Vision for 2015* which represents the new ambition of the North region of Portugal, in terms of innovation.
  - *The establishment of objectives and strategic lines* where the defined vision is materialised in strategic intervention lines for the development and promotion of a regional innovative North region.
  - *The definition of strategic lines* for the development of the North region, focusing on an innovation policy.
  - *The definition of a set of priority actions* for each strategic line in order to materialise the defined strategic objectives.

- *The establishing Pilot-projects* within the defined priority actions, which represent the RIS ‘flag’ initiatives as aggregators around the established strategic lines.
- *The implementation of an action plan* which is assumed as an aggregating document of the RIS actions gathering main deadlines, financial resources and key people.
- *The definition of a monitoring and evaluation system* where a supervising system for the RIS implementation is established.

This article focuses on the diagnosis of the ITCE clusters and on the results of the regional innovation strategy contemplating the establishment of the vision stage until the definition of priority actions.

#### 4 ITCE clusters in the North of Portugal

This section is a summarised version of the study of the ITCE clusters of the North region as presented in NORTINOV 2015 project (CCDRN, 2004a). It is divided in three parts. The first one presents the main global contextual factors influencing the ITCE clusters. The second part presents the Northern region context and the third part puts forward a synthetic SWOT analysis of the ITCE clusters.

##### 4.1 Global context

The main key figures of the global market of the ITCE clusters are presented in Table 1. While the USA leads in the IT market, Europe leads in communication and electronics.

**Table 1** Main global market figures of the ITCE clusters

	Market (Billion €)	Market Share (%)			
		USA	Europe	Japan	Rest of the World
IT	933	42	31	12	15
Communications	1165	25	28	13	34
Electronics	1192	29	36	12	23

The growth rates of ITCE clusters are shown in Table 2. The annual growth rates are moderate for both communication and IT markets. As the growth rate of the electronics market has been poor, China is expected to exceed Europe’s production volume before 2010 although not exceeding the USA (EITO, 2004).

**Table 2** Growth rates (%) of European ITCE clusters

	1998/2000	2001	2002	2003	2007
IT	11	2	–	–	4
Communications	13	4	–	–	4
Electronics	–	–	–13	–2	0

The difference in *percapita* consumption of IT markets is broad: while it exceeds €1500 in the USA and €20 in Japan, it does not reach €250 in Portugal (EITO, 2004). With the globalisation and concentration process of ITCE sectors, there is a growing tendency for the centre of gravity of business to shift to Asia due to the growing importance of local markets and production activities in the Far East (CCDRN, 2004a).

Among the main driving forces of the ITCE clusters, the following are very important:

- the growing importance of *e-business*, *m-business*, third-generation mobile networks and broadband for the e-economy
- the importance of *software*, *wireless* and mobility
- the emergence and subsequent strong growth of the multimedia market
- the investment in human resources and knowledge, which is essential for future growth
- the e-commerce and adoption of web technologies by enterprise applications.

#### 4.2 Regional context

Portugal is a small country with a population of ten million inhabitants and a per capita Gross Domestic Product (GDP) of €12,600. Although a member of the EU, Portugal is considered to be a *less-favoured country*. Its industrial structure has a long manufacturing tradition although largely specialised in traditional low-tech industries.

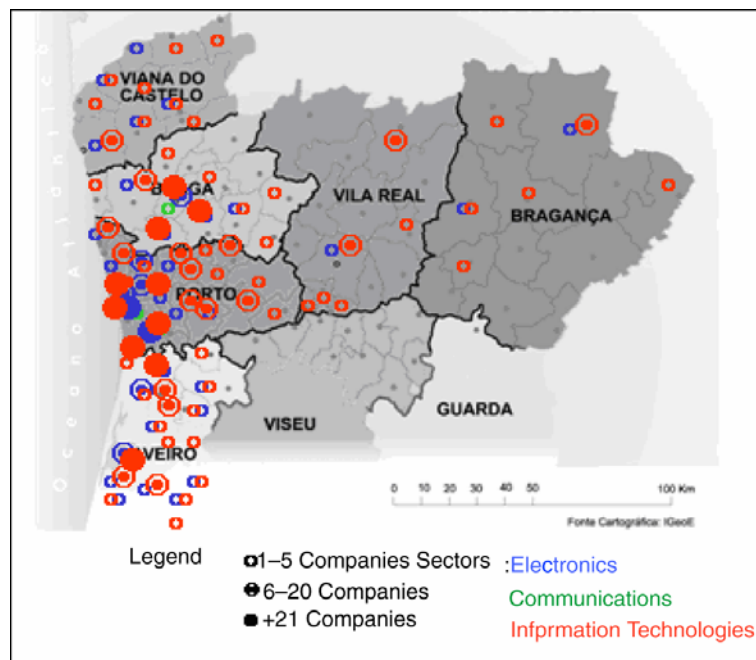
Structurally, the Portuguese industry is described as:

- a myriad of SMEs concentrated along the West coast characterised by limited technological competencies
- a limited number of large companies
- a small market for technology-based products.

The key figures of the northern region ITCE clusters are shown in Table 3. Although the electronics cluster has a high share due to the presence of some multinational companies in the region, the northern communications cluster owes its low share to the location of the main telecommunications operators in Lisbon (CCDRN, 2004a). There is a high geographical concentration in the districts of Porto (59%), Aveiro (17%) and Braga (17%), as shown in Figure 2.

**Table 3** Key figures of the ITCE clusters of the Northern region

Cluster	Number of firms	Turnover		Employment	
		National Total (Million €)	Share (%) of national cluster	Number employees	Share (%) of national cluster
IT	996	175	16	3807	20
Electronics	156	1892	42	8589	20
Communications	4	42	20	177	0.9
Σ	1156	2110	–	12,573	–

**Figure 2** Territorial distribution of ITCE clusters of the Northern region

Source: CCDRN (2004a).

In order to characterise the regional context, it was decided that, apart from bibliographical research, work visits would be made to specialists of each industry. The objective was to conduct a survey relating to disperse information about different clusters, on one hand, and to gain a real notion of field conditions, on the other hand. Equally, in order to complement this information, technological audits were conducted in 11 key companies and in 10 R&D institutions in the region. These audits, which followed a qualitative approach, helped to monitor how leading entities of the northern region were performing, what technologies they were using, what competencies they had and lacked, what types of R&D projects they were involved in and what the future perspectives looked like. They also helped not only in the creation of a list of emerging technologies for the year 2015, but also in the exploration of the regional competencies in the ITCE sectors.

In order to convey the technological audits, two questionnaires were developed, one to business firms and other to R&D organisations that included the following themes: general characterisation of the institution, main competencies, products and markets, main research priorities and results, human resources, main R&D projects, present key technologies, development potential, relevant emerging technologies, developmental potential and regional environment.

A list of emerging technologies was obtained, 35 from the IT clusters, 36 from the communications sectors and 19 from the electronics industries. In order to identify the critical technologies for the North region for the year 2015 the major players of the ITCE clusters were invited to attend a workshop in which the main purpose was twofold: to classify all emerging technologies and to assess the technological capabilities for the strategic development of the ITCE clusters.

Table 4 reports the technologies and the competencies found in the ITCE clusters of the Northern region, where it is possible to conclude that the region has strong R&D capabilities in 7 of the 30 critical technologies, being the IT sector the one with the strongest R&D competencies. On the other hand, the business sector of the region has strong competencies in only two of the 30 critical technologies found. The communications sector is in relative disadvantage when compared to the other two clusters.

**Table 4** Report on the technologies and regional competencies of the ITCE clusters

	<i>IT</i>	<i>Communications</i>	<i>Electronics</i>
Emerging technologies	35	36	19
Critical technologies	15	7	8
Strong regional competencies in R&D institutions	5	1	1
Average regional competencies in R&D institutions	10	7	6
Strong regional competencies of the business sector	1	–	1
Average regional competencies of the business sector	11	3	7

Another important aspect considered during the definition of the critical technologies was their transversal influence in the different clusters analysed. It is possible to argue that a great deal of companies of the IT cluster could be considered as specialised suppliers. On the other hand, the applications generated by this cluster have important effects in information intensive sectors.

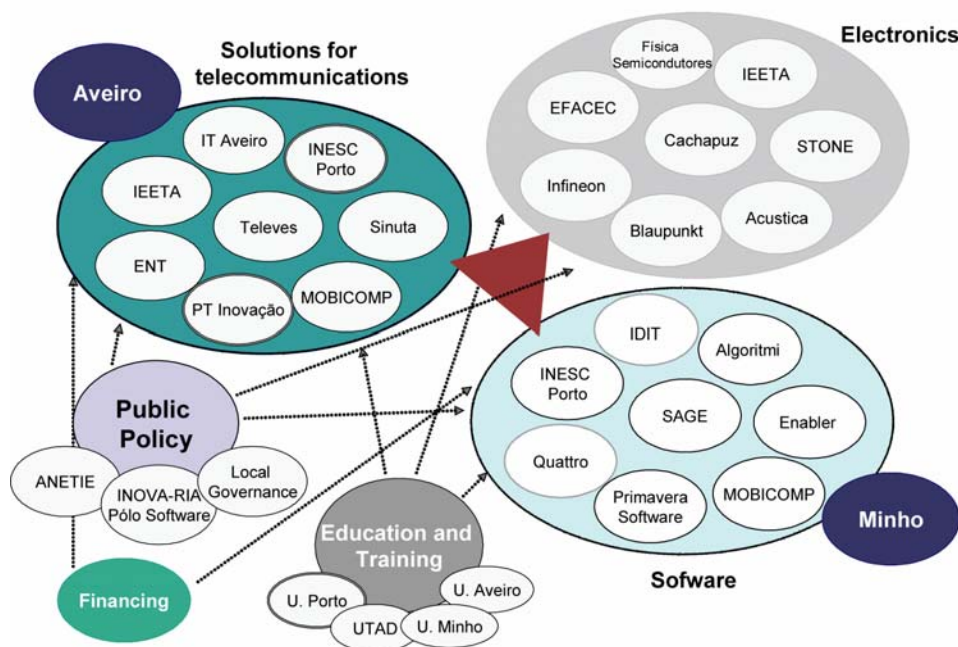
Although some critical technologies of the electronics cluster are associated to the science-based sector, they have pervasive applications on the IT and communications clusters, as is the case of the low energy consumption systems, local energy generation systems and RFID.

Finally, the communications cluster has a set of critical technologies that are vital to the society, both in social and economic terms that should not be overlooked, as is the case of wireless wide band internet. The shape of the ITCE cluster is shown in Figure 3.

The majority of Portuguese companies that develop software products are located in the northern region, which is a strong regional asset (CCDRN, 2004b). Most ITCE companies of the northern region, with the exception of foreign multinationals of the electronics cluster, do not develop clear internationalisation strategies. The IT cluster companies recognise internationalisation as an indispensable condition for their survival in the market.

The main motivating reasons given by companies for internationalisation were the small dimension of the national market and the saturation of some segments of the Portuguese market. The main obstacles to internationalisation elucidated were: the poor high-tech image of Portugal abroad, the small size of national companies relative to their main competitors, the need for high levels of investment and the lack of governmental support.

Figure 3 The shape of the North region ITCE Cluster



Generally, although most foreign multinational companies do not hold product development activities, most of the remaining companies do. The major barriers to innovation are related to the small market size, the amount of investments (for SMEs) and the lack of innovation culture.

In most foreign multinational companies, strategy is focused on optimisation of processes and costs. In Portuguese companies, the strategic positioning is based on three main strands: the conquering of new markets, the nurturing of international ventures and the focus on market niches.

Generally, companies consider that their human resources are rather competent. Despite new graduates' excellent background, they still lack innovation and enterprising spirit. Most of the gaps found in education are related to the shortage of a skilled workforce and to the low level of mobility of the region's human resources. In general, business firms believe that universities in the region assure an up-to-date background knowledge; however, they feel those same universities do not fulfil their needs when it comes to specific and specialised training.

There are 28 R&D institutions in the northern region with competencies in ITCE sectors. Among them, 23 are R&D entities affiliated to universities, with five of them holding competencies in the areas of Electronics, five of them in the area of IT and electronics, three in the areas of ITCE, one in electronics and telecommunications, two in the IT and Communication, six in IT and only one in the telecommunications area (CCDRN, 2004a).

A total of 479 PhD researchers were identified in the region, 399 of them being in R&D higher education institutions in ITCE-related clusters, four in interface institutions and 76 in FCT's associated laboratories.

There are 16 higher education institutions awarding higher education degrees (Baccalaureates, Master's and PhDs) in ITCE clusters. Four of them are public institutions, four are private and eight of them are polytechnic institutes (CCDRN, 2004a). In all higher education institutions, 123 degrees related to ITCE clusters were detected, 60 of them undergraduate degrees, 46 at the level of post-graduate and master's degrees and 17 PhDs. In 2002–2003, the total output rose to 1017 undergraduates and 44 at the level of post-graduate or master's degree.

There are several European and national initiatives surrounding the *information society* concept that, directly or indirectly, benefit the ITCE mega-cluster. Nevertheless, although there are several technological and industrial policy instruments that players of ITCE clusters can make use of, there are no specific sectoral policies oriented towards this mega-cluster.

Some programmes and structuring projects have been created to strengthen the development of the ITCE clusters in Portugal articulating public policy, sectoral associations and business firms' interests. Projects of particular note are the *Digital SME* initiative, the *Digital Cities and Regions* and the *National Programme of Electronic Purchasing*.

The strong concentration of software firms and universities in the region was identified as one of the main enablers allowing the creation of a software development regional cluster. The main restrictions were associated with the absence of a culture of innovation and entrepreneurship and to the lack of *business angels* and venture capital specifically focused on the sector.

#### 4.3 Characterisation and swot analysis of the ITCE clusters of the North region

Following Asheim and Isaksen (2002) typology of RIS the communications cluster is characterised as a territorially embedded regional innovation network as the interaction with regional knowledge producers is very modest and innovation is generally incremental in nature. The IT cluster is characterised as a regional networked innovation system as networking activities between universities, R&D institutions and SMEs play an important role.

The classification of electronics clusters is very difficult as Portuguese firms are generally small and medium-sized firms quite developed in production-related services with strong networking activities with universities and R&D institutions. On the other hand foreign multinational firms follow isolationist strategies with low contribution for and from the regional innovation network. This dualistic behaviour makes it difficult to clearly classify the cluster.

Following Heidenreich (2004) typology of Entrepreneurial or Institutional RIS it is difficult to arrange the clusters under analysis. The IT cluster and an important share of dynamic SMEs of the electronics cluster are characterised by flexible interorganisational networking activities being able to face competition from companies all over the world. On the other side large foreign multinational companies of the electronics cluster follow learning and innovative strategies imposed by their headquarters, which jeopardises any contribution to the region's knowledge base as interorganisational cooperation with their regional actors is reduced and focused on headquarters strategic interest. The main challenge of the RIS is to generate added value throughout the supply chain and to avoid lock-in effects of investment-divestment cycles.

Finally, the North region communications cluster is too small to be a reliable partner and suffers the effects of dirigiste governance of the industry and is strongly dependent on the Lisbon-based competitors.

Another point that deserves a close scrutiny is the regional governance of the ITCE clusters, which is very peculiar from the regional innovation point of view: Portugal's lack of regional governance tradition. In fact one of the main characteristics of the Portuguese economic policy is its unified national industrial and innovation policy embracing all technological fields, which is typically of dirigiste, state-dominated innovation systems where the state holds a dominant position. As a consequence, innovative networked patterns have a low impact on regional/local firms as regional and local interests are submission to the national ones.

Tables 5–7 summarise the main strengths and weaknesses of the ITCE clusters of the North region as developed in CCDRN (2004a,b).

**Table 5** SWOT analysis of IT industry of the North region

<i>Strengths</i>	<i>Weaknesses</i>
Strong concentration of Universities	National market and expenses in IT are small
Strong software cluster	Small average firm size
Young human resource base	Weak innovative and entrepreneurial culture
Several important case studies	Absence of Business Angels
	Short-term strategic orientation
<i>Opportunities</i>	<i>Threats</i>
Beginning of a new mobility wave	Growing competition
Growing entertainment and elderly markets	Growing Standardisation
Lack of educational and cultural contents	Management applications for SME's software market not only reduced but also under attack from strong players
Proximity to Spanish market	
Small entry barriers	
Growing national market	

**Table 6** SWOT analysis of the electronics industry of the North region

<i>Strengths</i>	<i>Weaknesses</i>
Some firms are strongly internationalised	Very few firms in the industry
High foreign investment, but with weak local links	Foreign investment centred on productive areas
Strong S&T institutions	Weak investment in research and new product development
Good conditions for foreign investments	Weak image in the international markets
	Lack of Portuguese brands
<i>Opportunities</i>	<i>Threats</i>
Evolving changing market	Market dominated by large firms
Strong chances in market niches	Actual investments are under pressure of Asian competitors (Relocation Strategies)
	Growing competition and standardisation

**Table 7** SWOT analysis of the electronics industry of the North region

<i>Strengths</i>	<i>Weaknesses</i>
Some companies specialised in communications equipment	Main telecommunications operators are in Lisbon
Important research centres	Weak image in the international markets
Strong higher education	Lack of Portuguese brands
Innovative, demanding and developed national market	Strong entry barriers in communications equipments
Competencies in mobile services	
<i>Opportunities</i>	<i>Threats</i>
Growing market in mobile services	Demand of equipments dominated by large firms
Strong demand in software development	Growing competition and standardisation in communications equipment

## 5 Regional innovation strategy for the ITCE cluster

The Regional Vision for Automotive and ITCE clusters of the North of Portugal for the year 2015 was expressed in the following way: “The North of Portugal as a region of added value through the creation and production of knowledge-intensive, innovative and global products” (CCDRN, 2004c). For that vision to be achieved the automotive and ITCE clusters should work as innovation levers of the regional development.

The main lines to reach the presented vision were divided in the following three categories: the *Strategic line*, the *Sustainability line* and the *Structural line*.

While the *Strategic line*, is focused on creating the conditions for the development of an ITCE innovative cluster taking into account the critical technologies, the firms’ capabilities and the industrial knowledge to deepen the cluster specialisation, the *Sustainability line* is more focused on the pervasive effects the ITCE technological and locational assets can generate in their interaction with other clusters. Finally, the *Structural line* intends to develop the structural condition of the ITCE cluster in order to position the North of Portugal as an excellent, world-class region. This *Structural line* proposes measures to improve the regional innovation system related with the ITCE cluster.

### 5.1 ITCE strategic line

Taking into account the vision for the year 2015 and the context of the ITCE clusters, the following mission statement was proposed: “to structure the Northern ITCE cluster based on the axis Aveiro-Porto-Braga, with strong international orientation, where the region can be competitive and recognised at global level” (CCDRN, 2004c). Taking into account the region’s reality, the following essential strategic actions were proposed to achieve the defined vision:

- Once the North region concentrates most of the companies developing software products in Portugal, representing a significant critical mass in terms of number of firms, turnover, software engineers, and has a strong group of universities and R&D institutions, the strengthening of the software cluster underpinned in the conception and development of international software products was recommended.

In order to match the regional competencies with the critical technologies identified (CCDRN, 2004a) the following areas were pinpointed: mobile services and applications; ambient intelligence; collaborative support systems; e-business and e-government; business applications and business process modelling; applications based on RFID; geographical information systems; web technologies; business intelligence/data mining; content development and games.

It was recommended to invigorate the interaction between business firms and R&D institutions, the development of software competencies, the attraction of foreign investment and the support of the internationalisation processes. These recommendations are meant to facilitate:

- the transmission of knowledge by locational and relational proximity of agents
  - the generation of radical innovations
  - the transfer of learning opportunities from other regional innovative systems.
- As the few firms of the communications clusters have a strong technical and scientific competencies in international markets it was decided to propose the strengthening of the development of solutions in the following highly potential areas for the North region: Communications equipments for market niches; Hardware and software integrated solutions (appliances); Network management applications; Location and mobility applications; GIS; Innovative applications for automobiles; Applications for UMTS and Applications for VOIP.

The internationalisation support mechanism and the creation of a solutions test-base were strongly recommended. The former was considered mandatory for the software cluster to reach a critical mass and the latter aimed at the strengthening of the regional absorption capability of tacit and explicit knowledge.

- The strengthening of the electronics industry in specific market niches generated by spill-over effects from Foreign Direct Investment in the North region, which has a considerable activity in electronics. With this action the exchange of information between foreign and regional actors is expected to generate more interactive innovations – as well among actors of the supply chain – and therefore to increase the competitiveness of the cluster.

Despite labour-cost disadvantages when compared to Far-East countries, the following options were pinpointed as the most relevant ones:

- international specialised market niches; new product development and engineering services; opportunities in the national market; the technological upgrade of the capital equipment industry; rooting of foreign investments with emphasis on new product development and engineering activities that can underpin upstream relationships in the supply chain; telemedicine, industrial electronics, automatic identification systems, domotics, lighting and energy systems

The tendency for a growing incorporation of electronic systems in the automotive industry associated with the development of the automotive cluster in the Northern region constitutes an excellent opportunity for the development of partnerships with auto industry first-tier suppliers in order to ease the diffusion of innovation to other business sectors and throughout the supply chain.

- The enhancement of the development of cultural, entertainment and educational content applications for both the internal and global market.

The strengthening of content applications is important for the creation of new economic and social dynamics. For example, the development of youth-driven contents in S&T areas or the development of the North region's tourist supply is expected to underpin not only the software cluster but also the whole economy as it generates important economic externalities. This type of projects can generate radical innovations that encourage the competitiveness of the whole economy as it improves not only intraregional support innovation but also builds a nationwide culture of receptivity to innovation.

- The promotion of the supply of shared services as IT and communications data centres, software development, technical support services, training, design and engineering services and call centres in order to facilitate the diffusion of knowledge among actors.

The promotion of these services can also constitute an important opportunity for the inner part of the Northern region due to the existence of the necessary competencies and to the appropriate communications infrastructure throughout the region.

In order to underpin the above mentioned strategic lines the following strategic priority actions were defined (CCDRN, 2004c):

- *Action 1*: the organisation and strengthening of the ITCE cluster as a whole in which all the players are intertwined in order to create a knowledge network.
- *Action 2*: the enhancement of the firms' internationalisation. This intervention is associated with the international dimension of the world market and with the reduced critical mass of most of ITCE companies of the Northern region. Some anchor firms will be essential for this action to have pervasive effects.
- *Action 3*: the development of competencies and competitive human resources for the ITCE clusters. The opportunity to articulate university and research institutions with the business sector should be highlighted so that knowledge can flow from eager knowledge providers to receptive business firms and consequently more radical innovations can be more easily generated.
- *Action 4*: the fostering of firms' critical mass and cooperation.
- *Action 5*: the attraction of foreign investment and the creation of new firms. It is also important to close the gaps throughout the value chain in ITCE clusters. A programme for the creation of new technology-based firms is also important to enhance the industrial density of ITCE firms in the region. The main purpose is to strengthen the regional absorption capability and to encourage the transfer of learning opportunities so that new emerging technologies can be endogenously generated within the region.
- *Action 6*: the dynamisation of the internal demand. Firstly, through the development of a financial aid programme in order to foster IT firms investment. Finally, through the development of a programme to digitalise the Public Administration.
- *Action 7*: the promotion of new models to finance innovation, namely through incentives for new technology-based firms and through the creation of a *Business Angels* network for the ITCE clusters in order to generate new emerging technologies.

## 5.2 ITCE sustainability line

The main goal of this sustainability line was to induce the interaction between the ITCE and the automobile clusters as well as to spark off the pervasive effects for the rest of the business fabric. The objective was to induce change in more traditional sectors, promoting the region competitiveness and sustainability.

The automobile-ITCE intercluster interaction intends to induce in the (automobile) product, processes and business models the integration of ITCE technologies and the promotion of the mobility as an 'utility' in the car industry.

The promotion of pervasive effects to other industries due to the ITCE horizontal nature could be of crucial importance in underpinning the competitiveness of other industries in which the North of Portugal has strong traditions.

In order to underpin the above mentioned sustainability lines and taking into account the regional industrial structure and technological competencies, the following priority actions were defined (NOTINOV, 2004c):

- *Action 1*: the integration of ITCE technologies in textile products and materials in order to promote the interaction of ITCE technologies in the textile industry.
- *Action 2*: the enhancement of the capital equipment industry through the launch of a Technological Upgrading Programme involving ITCE technologies in the production of competitive international-based capital equipment.
- *Action 3*: the launch of a regional *Mobility* project to promote the intersection between the telematics and transportation sectors at regional level. The idea was to aggregate the industrial, regional, scientific and technological competencies for the development of new human and information mobility solutions.

These three actions aim at encouraging the transfer of knowledge-intensive technologies between sectoral innovation systems so that innovation become a watchword and the ITCE cluster can evolve towards new technology trajectories.

## 5.3 ITCE structural line

The Structural Strategic Line aimed the strengthening of the structural conditions necessary for the development of the ITCE innovation system and to overcome the limitations described in previous sections. The following strategic actions were identified (CCDRN, 2004c):

- The development of efficient and effective regional strategic governance as well as a consistent territorial marketing underpinned in the abovementioned vision and mission. This issue is of crucial importance for the international competitiveness of ITCE clusters, for the attraction of structural foreign investment, for the development of innovative solutions and for the creation of a solid international image.
- The strengthening of solid intermediate qualification, which was one of the handicaps of the region. The attraction of high quality technical employment. The intention was to attract young human resources for the engineering and S&T areas in order to empower a new social culture that facilitates creativity and social interactions across individual and organisations.

- The financing of results-oriented innovation taking into account the scientific/technical initiatives as well as the marketing/innovation merit.
- The development of physical accessibilities, wide band access and the digital economy in order to sustain its competitiveness, to elevate its economic prosperity and to achieve a phenomenal growth in technology learning.
- The generation of regional strategic information in order to underpin both public policy decision makers as well as business managers in key areas as markets, technologies, products, firms, R&D institutions and international programmes.
- The development of an entrepreneurial culture and an innovative environment in order to shift the region's paradigm to a knowledge intensive era in which collective knowledge and creativity are the main key-success factors.

## 6 Concluding remarks

The purpose of this paper was to present Portugal's North region innovation strategy for the ITCE clusters for the year 2015, as presented by the *NORTINOV 2015* project and to address the main challenges the region faces to operationalise the defined regional innovation strategy.

Clearly, a regional innovation dynamics seems to have emerged on the IT cluster since some actors have emerged as major global players within the region. On the other hand, the large foreign multinational companies of the electronics industry have not been able (or willing) to promote interorganisational networking activities due to their isolationist strategies as new product development and R&D activities take place mainly at headquarters' level, which not only jeopardises networking activities with local players but also hinders regional innovation dynamics. The differentiated behaviour can be explained by sectoral differences in mobilising other types of competencies and by the lack of involvement of local innovation governance at the time those foreign multinational firms rooted their activities in the North region and afterwards.

The industrial structure of the North region is clearly different in the three clusters analysed. While the IT cluster concentrates a good deal of software firms in Portugal, the communications cluster is rather weak. The electronics clusters shows a dualistic setting in which the foreign OEMs and Portuguese SMEs hardly cooperate.

From the technology standpoint the situation is different in all clusters regarding the critical technologies for the year 2015. While R&D institutions have strong competencies in five of the 15 critical IT technologies, the R&D institutions only have strong regional competencies in one of the critical communications technologies and in one of the eight critical electronic technologies. The situation is less comfortable regarding the business sector: the IT cluster and the electronics clusters have strong competencies in one critical technology. The challenge is straightforward for the ITCE clusters: as technology cannot be internalised from alternative sources the business sector and R&D institutions have to develop sufficient capability to crack the emerging technologies on their own.

The industrial structure and the relative disadvantaged situation regarding the development of the critical technologies for the year 2015 pose a strong issue for the North region in sustaining its international competitiveness in the coming decade: the

growing importance of innovation capability and the strong efforts to strengthen university-R&D institutions-industry collaborations, which are still on the formative stage.

While building a strong innovation capability to make change happen, the strengthening of university-R&D institutions-industry collaborations is important to generate, use and disseminate knowledge. Clearly, if the North region fails in this systematic way of promoting localised knowledge it will hardly succeed to secure a competitive advantage.

The venture capital industry is in its infant stage all over the country, largely because of its small dimension, which is a major drawback of the RIS because it hinders not only entrepreneurial venturing, but also several major initiatives in R&D.

One question still remains: can a region implement a regional innovation strategy that has been defined taking into account sectoral systems of innovation, especially when it is going to be implemented by dirigiste, centralised governmental body?

As mentioned before, the IT cluster and part of the electronics sector are characterised by a strong entrepreneurial RIS, being the remaining part of the electronics cluster and the communication clusters characterised by a dirigiste RIS. Accordingly, the main challenge at infrastructural level is to develop a competence embedded university-R&D institution-industry collaboration in order to face, on the one hand, the challenges of new emerging technologies and, on the other hand, to avoid become locked-in to the stability of the institutional order of dirigiste, centralised decision-makers. At firms' organisational level, it is mandatory to implement a cooperative-based practice so that innovation can be highly promoted and pursued throughout integrated value-chains in order that knowledge can easily flow among the business fabric.

Although it is our belief that the priority actions pinpointed during the definition of the regional innovation strategy for the ITCE clusters will surely improve the North region's competitiveness it is still doubtful that a centralised, dirigiste type of innovation governance can improve the innovativeness of the regional innovation system as relationships are developed between actors within a territory.

It is important to realise that all strategic actions – whether they are the result of the strategic line, sustainability line or the structural line – are required in order to increase the regional innovativeness significantly. They are intertwined as the strategic line stems from the creation of the conditions to close the gap of the regional competencies, according to the critical technologies defined for the year 2015, while the sustainability line is expected to underpin specialisation and facilitate interaction within other clusters and the structural lines defined the target vision and mission for the year 2015.

Although these three lines are defined (and are necessary) they are not sufficient to deploy innovation: it is mandatory to have a high level of regional involvement (and governance) in order to spark off the sustainability line and to properly address regional actors, and to promote regional cooperation among them, as is happening in the IT cluster and in part of the electronics cluster.

Despite its economical, historical, geographical and technological peculiarities, this prospective exercise is of added value for a group of countries and regions that are implementing prospective innovation studies. Although this methodology and the governance doubts vary from country to country and from region to region they are also pertinent to other regions in developed countries, as well as to other small economies all over the world, trying to overcome regional (national) disparities *vis-à-vis* other regions (nations).

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