MAPPING THE INTELLECTUAL CAPITAL OF CITIES AND REGIONS

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ABSTRACT

Contemporary cities or regions have complex challenges that require ongoing monitoring enabling intelligent answers in an appropriate period of time.

There are many studies that indicate that this monitoring should take into account not only the tangible assets, but also the assets of intellectual capital. Several authors consider that these are the assets that are crucial either in sustainable innovation processes either in the process of developing the necessary reputation for building strong brands, able to attract talented people and investments.

Based on the literature review and preliminary studies that compare the metrics for evaluating the intellectual capital of companies with the intellectual capital of the countries, this paper presents a theoretical model supporting the auditing and the mapping of intellectual capital management of cities and regions.

This process is based on the creation of sensors for monitoring the intellectual capital and on the evaluation of how these are managed so as to support the decision making of the decision-makers and economic policy-makers.

With this paper we intend to broaden the discussion on the importance of the decision makers of the strategies of cities or regions to support their choices on criteria that take into account the assets of intellectual capital.

Keywords: cities, regions, intellectual capital.

INTRODUCTION

The aim of this exploratory work is to identify and characterize possible investigation lines related with the problem of regional IC (cities and regions) to be explored in future work. From the literature review – see part 1 – it is not entirely clear what are the relations between the IC of entities at distinct levels of territorial organization, although it is intuitively appealing to consider, for example, that the IC from an enterprise is a function (what function?) from the IC of persons that composes that enterprise and that the IC of a city must consider (how?) not only the IC from the enterprises, other organizations and institutions that integrate the city, but also the IC of the people connected in other ways with the city- not being entirely clear if the definitions should be the same, independent of level, and if its meaning is invariant through the hierarchy of units. This kind of questions is the object of part 2 of the paper. In part 3 we explore questions associated with a possible methodology to use when we come up with the need to specify a system capable of helping in the development and management of the IC of specific territorial units (city, region, metropolitan area...). What are the relevant concepts? Is there a set of conceptual components useful for this and invariant with the level of units? What must be the nature of a possible IC mapping of a specific unit? How can that IC mapping be monitored and updated? This is the more speculative part of the paper and must be seen as an effort integrated in an ongoing task, an exploratory work and not as a finished work. Part 4 – conclusions – presents the main findings of this exploratory work.

1 - LITERATURE REVIEW

The macroeconomic researches on intellectual capital have emerged in the early 2000s. Researchers and some governments (particularly the Danish and the Dutch) realized that it was important to know and measure the intellectual capital of countries, regions and cities.

Some of these studies have had a major impact on the recognition of the importance of measuring intellectual capital at macro-level. The main purpose of these studies on intellectual capital is to produce guidance on economic development (e.g. Andriessen & Stam, 2004). However, it has often been mentioned that the models for measuring intellectual capital, adapted from business models, have many flaws (e.g. Ståhle & Ståhle, 2012; Lazuka, 2012).

If we analyse the models of intellectual capital applied to cities or smaller urban units (e.g. villages), we find that there is even less literature. Usually, we consider two approaches: the first one, based on the measurement of intellectual capital of companies as proposed by Edvinsson and Malone (1997); the second one, based on the macro-level of countries.

There are some approaches to the subject of intellectual capital applied to cities, in particular: Carrillo (2004) studied the knowledge cities, identifying three types of capital (human capital, meta-capital and instrumental capital).

Viedma (2003) proposed a methodology (CICBS - Cities' Intellectual Capital Benchmarking System), a methodology to measure intellectual capital of cities, consisting of two models: a model formed by the vision, resources, skills and indicators, based on "Skandia Navigator", and another that identifies the micro-clusters of the city.

Rodríguez et al. (2004) developed a model for the intellectual capital of the Madrid region based on the "Intellectus model", with five variables of regional capital: human, organizational, technological, social and financial-economic.

Bossi et al. (2005) adapted to the cities, the methodology of intellectual capital in the public sector. According to Schiuma et al. (2008), city's competitiveness depends on its innovation capacity. Authors divided city's knowledge capital into the four categories: human, relational, structural and social.

Bounfour (2005) also investigated the intellectual capital of the European Union countries, using a measurement model at the macroeconomic level.

Schiuma, Lerro & Carlucci (2008) used the "Regional Intellectual Capital Index" (RICI) to create a set of indicators for regions.

López et al. (2008) proposed a model applied to 25 regions of the European Union.

Ståhle and Bounfour (2008) have sought to understand the impact of intellectual capital in the economy. These authors used relevant macroeconomic indicators for 51 countries and showed that indicators related to intellectual capital have different impacts on the GDP of a country and on its economic growth. They attribute these differences to the different stages of economic development.

Corrado et al. (2009) used models developed for the macroeconomic level in order to attempt to estimate the weight of intangible assets in the U.S. economy.

To Cabrita and Cabrita (2010), the most important factors influencing cities intellectual capital are the operations of creative industries. They divided the creative industries resources into four categories: human, institutional, organizational, physical and social.

Ergazakis and Metaxiotis (2011) presented the "KnowCis 2.0 methodology", a methodology proposed for the formulation of a Knowledge Cities strategy.

Alfaro, López and Nevado (2013) presented the MEICC, a theoretical model to measure and evaluate the cities intellectual capital. Before this authors had presented a model to measure national intellectual capital (Alfaro, López & Nevado, 2011a) and a model of estimation of intellectual capital in the European Union (Alfaro, López & Nevado 2011b).

There are other studies that have ranked the cities, for example, the study by PricewaterhouseCoopers (2012) and the studies of Mercer Human Resource Consulting (2010) and Mercer's Location Evaluation and Quality of Living Report (2015). These studies have rakings of cities based on some recognized indicators of intellectual capital.

According to some authors (e.g. Andriessen & Stam, 2004) it was not necessary to develop new models for macro-measurement of intellectual capital, since the concept of intellectual capital was transferable from a micro-level (enterprise) to a macro-level.

This approaches consider the statistical relationship between the various components of intellectual capital and the level of economic development of the region or city and the intellectual capital is defined as intangible attributes of the region's residents, businesses, institutions, organizations, public structures, communities and administrative units,, that represent the identity of the region and which are potential sources of future improvement and economic growth.

2 – REGIONAL IC – A MULTILEVEL PERSPECTIVE

The territorial units that are the object of IC form a natural hierarchical structure whose levels are: person, organization, city, metropolitan area, region, nation and state; just to mention the main levels.

The concept of IC makes sense for all the aforementioned units and is useful as a subject of study, economic and political decision. A legitimate methodological question is to know if the definition of IC to be used with the units at distinct levels of the hierarchy – and the corresponding observation, measurement and statistical methods – must account for the levels or should/can be the same.

Sometimes – see for example Navarro *et al* (2014) and Viedma (2013) - the problem is not the hierarchical relations between units but the fact that it is necessary to compare/benchmark or associate units of the same hierarchical level, belonging to distinct geographical places or having economical or technological distinct status: the question of comparability or isomorphism between similar units.

Contrary to what happens with other domains – for example students' evaluation in educational science, health and behavioral science – in the IC consulted literature we did not notice similar formal concerns about the consequences of the hierarchical nature of units for the statistical methodologies. For example, if the students are grouped in classes and the classes are grouped in schools, the features of classes and schools must count in the explanation of average classifications obtained by students. See, for example, Goldstein (1987, 2003), Leyland et al (2001).

Specifically, suppose we have two units belonging to the levels l and $l + 1$. For example: l for City *(C)* and $l + 1$ for Region (R). Is *IC (R)* the sum of the *IC (Ci)* for all cities *Ci* $(i=1 \ldots nc)$ belonging to the region R? It is clear that IC of the region must be some function of IC of its cities, but what kind of function? On the other hand, it seems also clear that this function must be completed with the contribution of some other intangibles, when we pass, say, from the level of city to the level of region.

Let us illustrate this kind of problem with an example involving the concept of NIC - National Intellectual Capital – see Lin *et al* (2011), and the concept of EIC – Enterprise Intellectual Capital as proposed by Matos *et al* (2013).

According to Lin *et al* (2011), NIC is obtained grouping in 5 components the 29 indicators described in table 3.1 of Lin *et al* (2011). The data used by Lin *et al* (2011), can be seen in table Lin *et al* (2011). Those components are HC - Human Capital; MC - Market Capital; PC - Process Capital; FC - Finance Capital; RC - Renewal Capital.

On the other hand, according with Matos *et al* (2009), data from a random sample of 100 firms was obtained using a questionnaire formed by 97 indicators, measured in a Likert scale of 5 values. Those measurements were aggregated in five (I, II, III, IV, V) variables or quadrants that previous studies had shown to be the adequate. The result is a data set whose rows correspond to 100 rows and five columns, corresponding to the quadrants: I, II, III, IV, V.

Employing the same methodology (principal components/biplots) to analyze both data sets, we came up with two plots (biplots) with a similar structure. See figures 1 and 2.

Figure Nº1 - Biplot for 40 countries
Five quadrants (I, II,…V)

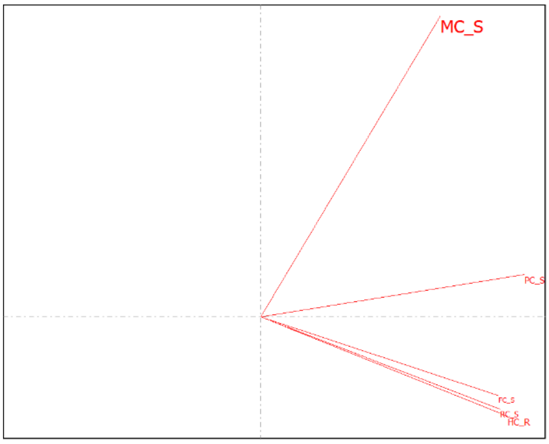
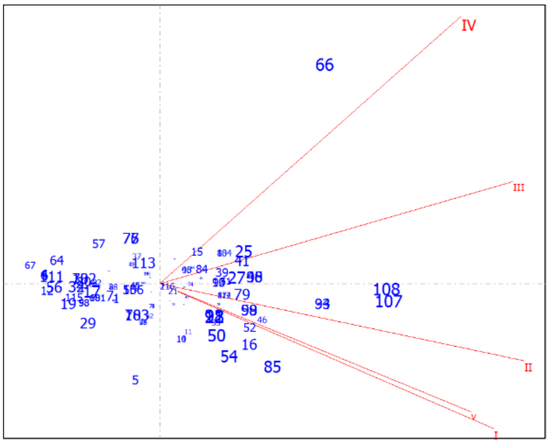


Figure Nº2 - Biplot for 100 firms observed
on 5 quadrants HC, MC,…RC



As can be seen, although the two plots were obtained out of two data sets constructed with data resulting from observing units at distinct levels of the hierarchy (Countries I, the case of Liu *et al* (2011) and Enterprises in the case of Matos et al (2009)), belonging to distinct realities, the structure of the constructs is very similar.

We can see that variable MC_S (Score for Market Capital) in the plot 1 corresponds to quadrant IV, approximately with the same meaning; PC_S (Score for Process Capital) corresponds to quadrant III (approximately with the same meaning) in the second plot.

This similarity seems to transcend the topological structure and to touch the semantic level; it would justify the hypothesis formulation that it is possible to use the same definition of IC both for Enterprises and Countries.

This example is, possibly - depending on hypothesis validation- an illustration of the problem formulated in Tay *et al* (2014): is there, in this case, evidence of the presence of an isomorphism between the definition of IC for units of distinct hierarchical levels? How to define and validate such isomorphism using a mix of observational and random data?

For a similar kind of problem – now related with possible isomorphisms of regions – see http://s3platform.jrc.ec.europa.eu/regional-benchmarking-tool where it is possible, using the European Smart Specialization Platform to find, online, reference regions based on structural similarities. See also Navarro *et al* (2014).

3 – REGIONAL IC – COMPONENTS OF SENSORIAL SYSTEM

Related with the problems of development of IC for cities and regions – or other territorial units of the hierarchic structure mentioned in the previous part – comes the practical question of specifying information systems to support both the development and the management of such processes. Is it be possible to obtain a common structure –independently of level – for an information system that supports IC mapping and decision tasks connected with the development of IC for a city or region? What should be the goals and main building blocks to use in the specification of such systems?

In what follows, we use as an inspiring paradigm the biological counterpart of formation and development of a human onscience (“Self”), as seen in Damásio (2010). We believe that the first condition to speak about a city or region capital intellectual (RIC) is the existence of a sense of belonging or membership to the city or region, shared by almost all its inhabitants, political corps, organizations and other institutions. There must be an intangible we could name City or Region Identity. This “feeling” of identity and belonging, is something that is built along a more or less large period of time, based in consensus, nurtured by shared values, interests, culture, language and a common history. All those intangibles - that we could name as collective Regional Identity - form, in our view, the basis *sine qua non* of a successful *development* of a regional IC. This development process seems to share with the development of a human self-consciousness, out of a biological reality, similar tasks and processes.

This approach – to base in nature the formulation and development of optimization algorithms and other models – is not new. To cite only two very well-known examples, consider what happened with the development of the computational method known as artificial neural networks - see for example (McCulloch *et al*, 1943) or (Haykin, 1999) - and the optimization methodology known as Genetic Algorithms (Michalewicz, Z., 1995) generalized to the concept of evolutionary computation, not to speak in the data analysis concept known as data mining, or learning machines, source of recent new and revolutionary concepts in statistics and data driven science.

Examining some of recent research, Damásio (2010) proposes a model of self-development of a human being and conscience formation out of a biologic basis from which it is possible to abstract some similarities with what seems to happen in the process of development of a collective conscience, in which we found the basis for the development of a RIC model.

In Johnson-Laird (1987, 2010), we discover the formulation, experimental evidence and practical application of the concept of mental model that seems to explain the way human beings behave when reasoning, simulating in brain - through representations of reality known as mental models or images - the facets of reality relevant for the rational decisions in specific domains.

As living organisms, cities and regions seek not only to survive but also to perpetuate its existence developing as much as possible the respective potential to improve the welfare of their respective inhabitants.

The development and management of Intellectual Capital (IC) of a city or a region should be seen in this context and not as an end in itself. View (Stewart, 1997).

The key issues to consider in the strategic management of a city or region for which the development of IC is needed are related with the answers to the following questions:

1 - What makes people want to visit or live in the city or region? (Why do they come?)

2 - What makes people visiting or living in a city or region wanting to stay? (Why do they stay?)

3 - What makes current inhabitants or visitors feel they would like to leave the city or region? (Why do they leave?)

The monitoring of the sentiments of people in relation to these three questions is among the main functions of a system to develop and manage IC of a city or region, meaning that this is one of the main world representations to consider.

Obviously, the population sentiments have underlying economic issues such as employment, wages, prices level, housing, health, education, community facilities, quality of life, safety and access to culture, family issues, and political issues. That is, the fact that the city and the region attract and fix population means or has underlying the fact that the city or region has satisfactory and competitive responses (compared to other alternatives) to the questions asked. When one is led to consider the possibility of moving, do it long before the fact, using all the information available. That is, the city and the region must be able to predict as early as possible before its occurrence, the main changes expected, in what areas of activity and their respective causes, and, based in this representation of reality, take the necessary strategic actions. This can be done developing what one could call a sensory system of the city or region - or nervous system of the city - that continuously captures the relevant signals that determine the feeling of the inhabitants and forecasts the future sentiment of the population for the three attitudes identified, influencing what one might call the IC of the region or city. This development is inspired by what seems to happen with the human body and brain in which a sensory system that covers the entire body captures the basic data and forwards it to a central system where it is processed. A particularly important aspect of this process appears to be associated with the construction of mental images - see (Kosslyn, 1996) and (Damásio, 2010) - or mental models - see (Johnson-Laird, 1983, 2010).

Many of the reactions of the brain to stimuli captured by the sensors are purely automatic and seem to implement rules embodied in biological circuits, learned through biological evolution, without any reasoning process. See Damásio (2010). When reasoning, human mind focus not on real objects from the outside world but on dynamic representations (images and mental models) generated by the brain. As has been shown experimentally - see (Kosslyn, 1996) - these images are manipulated (rotated, for example) during the process of reasoning, as a result of computational processes that act on these images or other representations of the world stored in memory.

Having these references in mind, we think that the structure of a sensory system for a city or region could be specified using the functions and software counterparts of the corresponding human neuronal systems with the following components: Sensors (S), Representations Generators (RG), Representations (R) and Memory (M).

Sensors (S) - Graphical symbol: a circle. Its function is to collect data on a single aspect of reality, characterized by a single-variable which may have one or more components. Each sensor corresponds to a continuous flow of data (data stream) that will feed one or more decision-making processes. These data can be obtained directly from the outside world or from pre-existing data repositories- Memory (Databases). For example, a sensor can capture the answers to a certain question in a questionnaire periodically applied. Another sensor can collect textual information generated randomly by citizens using the respective mobile to report accidents, assaults, disorders, complaints, etc; another example: selected texts of the daily press may be collected by one or more sensors that transmit these raw data to representations generators of political sentiments or public opinion.

Representation Generators (RG) - Graphical symbol: a diamond. Representations generators receive sensor data and implement specific statistical, optimization, other mathematical and simulation models and other algorithms; also calculate or update specific representations of the real world for specific decision processes.

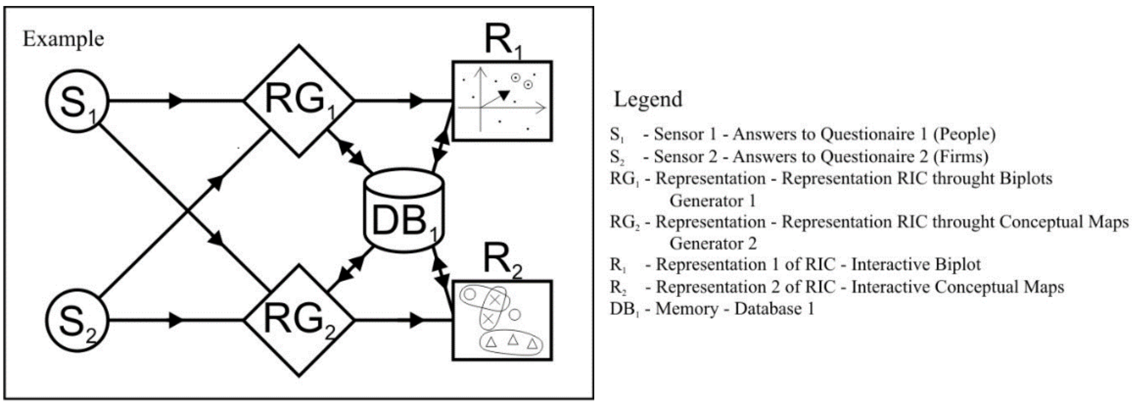
Representations (R) - Graphical symbol: a rectangle. Rational decisions are made reasoning on representations of the world or taking into account the current state of the world represented by these dynamic representations.

Memory (M) - Represented by one or several data bases to store the relevant knowledge about the system and the world.

Using these components we can specify information systems with directed graphs such as the simple example of figure 3. In this kind of graph, the existence of an arch A ⇨ B means that component B uses information supplied by component A.

In the specific case of figure 3, the system is composed by two sensors (S1 and S2).

Figure 3 - A system with two sensors, two representations generators, two representations (CI as an interactive, dynamical, conceptual map and CI as an interactive, dynamic biplot) and the memory of system (data base).



Assuming that the functions of these sensors are: Sensor 1 - to collect continuously the answers of people to questions of IC from universities of a certain region and Sensor 2 - to collect continuously the answers of people working in firms of that region to questions of an IC questionnaire such as the one proposed in Matos *et al* (2009). The data of Both data streams - after some preliminary transformations - is supplied to two specialized Representations Generators (RG1 and RG2) that generate and update the two world representations R1 and R2 with which users interact to decide. Just as an example, suppose that RG1 composes dynamic (continuously updated) and interactive digital plots of concepts resulting from the two streams generated by S1 (representation R1) and S2 and that

RG2 generates a dynamic interactive conceptual map (the representation R2), also resulting from the same data (S1 and S2) but created by a distinct algorithm. The memory of system is represented by one or several data bases (DB1) to store the knowledge generated by the system and by the interaction with users: data, states of system, events and decisions of users.

4 – SYNTHESIS AND CONCLUSIONS

With this exploratory paper we have identified some investigation lines and concepts that can guide future work in this domain:

1 - The relevance of multi-level statistical methodology for measurement and conceptualization of IC relating distinct territorial units.

2 - The relevance of concept of isomorphism to compare structures of IC for units at distinct levels of territorial organization and as an instrument of theoretical development.

3 - The relevance of modern developments in neuropsychology as an inspiring model for specifying information systems for development and management of regions and cities IC.

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