Eduardo Tomé (Editor)

Proceedings of the International Conference

Theory and Applications in the Knowledge Economy

TAKE 2016 – Aveiro, Portugal, 6 to 8 July 2016

Monitoring the Intellectual Capital of Cities and Regions

Florinda Matos and Válter Vairinhos
ICAA - Intellectual Capital Accreditation Association, ICLab Research Centre
Santarém, Portugal
florinda.matos@icaa.pt, valter.vairinhos@icaa.pt

Abstract: Contemporary cities or regions must respond to complex challenges that require continuous monitoring by sensors of a large number of variables, enabling intelligent answers in an appropriate period of time.

This monitoring should cover tangible and also intangible assets, such as intellectual capital (IC). Several authors consider that intangible assets 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, both at city and region levels. The IC concept is relevant for all the elements of the hierarchical structure starting in the individuals and including cities, regions and nations. In this context, several unsolved theoretical and methodological questions emerge, such as relating individual's IC with cities and nations IC. Empirical work, based on observations of nations IC and SME´s IC, shows that the topology of the corresponding variables is very similar at both levels, a fact that suggests some hints for future investigations.

This paper aims to identify, characterise and contribute to the formulation of unsolved conceptual and methodological problems related with cities and regions intellectual capital, namely the relations between IC of hierarchically related entities and the formulation of models addressing the problems of development of regions IC.

This paper is an exploratory study, only partially supported by data and based mainly in literature review. The data resulted from a sample of 112 SME´s observed, using a questionnaire related to IC management and observational data about countries IC, published in literature. For the formulation of possible models of cities and regions identity formation, relevant literature from neuropsychology was used.

The main findings, to be confirmed with future studies, were the relevance of the isomorphism concept to compare structures of IC for entities at distinct territorial levels and the relevance of modern developments in neuropsychology as an inspiring model for specifying information systems for development and management of regions and cities IC.

The literature suggests that a possible model for this process is the human counterpart of self-construction of mind out of the physical constituents of the human brain used in psychophysiology, which could be seen as the construction of cities and regions identity.

Given the relative novelty and strategic importance of this theme, the research of this subject is strongly conditioned by the scarcity of empirical experience and, consequently, by the scarcity of published data (open data).

This paper can contribute for the formulation of investigation lines and investigation projects in this strategic field, relevant to organizations, cities and regions.

Keywords: Cities, Regions, Intellectual Capital, Monitoring

Introduction

The aim of this paper is to continue a previous research on the same theme (see Matos and Vairinhos, 2015) trying to generalize IC, seen as a strategic management concept, from the micro level to the macro level.
The IC concept was created by Stewart (1997) to account the role of intangibles of the firms and the difference between the market value and the book value. Meanwhile, it has been observed (e.g.: Bonfour and Edvinsson, 2005) that this concept is relevant also as a strategic planning concept for other entities and organizations such as nations, for which the concept of "market value" is meaningless.
This means that it is needed some conceptual effort to explain how IC can also account not only for the difference between the market value and book value of a firm, but also to account for other natures of intangible "values" such as the capability to solve problems, support and sustain wealth of the inhabitants of cities, regions and nations.
The first theoretical concept that emerges in this context is the fact that cities, regions and other territorial organizations have not, apparently, an "intellect" or a "mind" that explains its intellectual production capabilities and assets.
Having this in mind, it is an evidence from management and social literature that concepts such as "learning organizations", "smart cities", "smart nations", "intelligent cities, regions and nations" emerge not only frequently in specialized management literature, but are useful and meaningful concepts used to manage and take decisions about important economic activities, political and social processes and, as such, having a real content, relevance, usefulness and importance.
In addition, the development of ICT (Information and Communications Technology) and the associated networks such as Internet, Internet of Things, Intranets, Social Networks, Sensor Networks lead, almost naturally, to the comparison of the processes of emergence and development of new ideas and concepts in the context of those networks to similar processes, occurring in the development of human brains and human minds, for which exists important scientific information, supported in theoretical and experimental experience.
More specifically: understanding and modelling the processes of formation and evolution of brain in several biological species and the emergence and development of a human mind out of its material support – the nervous system – poses similar problems and explanations to what is known about the self-organization of society and the relations between organizations of all kinds supported in the development of the Internet.
It is then "natural" – using a paradigm that has produced good results in other domains – to apply used theories to model and explain formation and development of human intellect as an inspiring model for the construction of models of formation of IC for non-human living entities such as cities and regions.

1 – IC as a Multilevel Concept

In this paper, IC considered as the potential to create value (see Cabrita and Cabrita 2006; Cabrita and Landeiro, 2010). This value means market value in the case of a firm or other kind of value for other kinds of organizations, such as wealth in the case of cities, regions or nations.
The entities for which it makes sense to speak of IC – be it people, organizations, cities, regions or nations – have in common some features, such as the capability to identify, select and pursue objectives and to take decisions accordingly.

Although, only people have a mind and the associated capability to think, all mentioned entities do not have a "mind" like the human mind, all are recognized in the literature as having the power to behave rationally and take reasoned decisions, coherent with its targets and aims, the result of this rational activity being intellectual results such as rules, laws, knowledge, software, other systems and organizational relations with similar or distinct entities.
The literature in the area of management is full of references to smart cities (European Council, 2000; EU Ministers; 2007), smart regions (European Commission, 2016), smart nations and also, social and collective intelligence, smart objects or smart "things" in the context of Internet of Things (IoT) (See Miorandi et al., 2014). In that literature, this rational behaviour attributed to some objects is not a simple literary form or intuitive idea, but has a precise meaning, assumed relevant and useful in the management of very concrete things. For example, in the European Parliament (2014), a city is "smart" when: "… investments in human and social capital and traditional and modern communications infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance".
It is an evidence that the entities – people, organizations, cities, regions, nations – form a hierarchical structure – see Figure 1 – where the entities of the same nature (for example, people or cities) are at the "same" level (l_1, l_2, l_3, …).

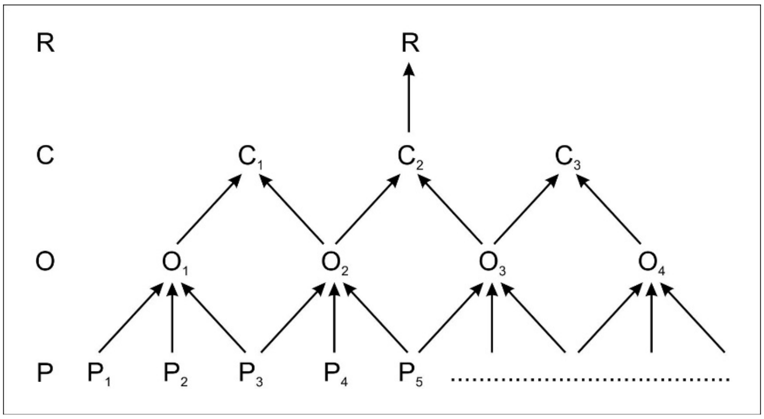

Figure 1 - The entities of the same nature are at the same level.
P – People; O – Organizations (including firms); C – Cities; R – Regions.

In this context, the problem that emerges is trying to relate the IC of entities at distinct levels of the hierarchy; this can be useful when it is necessary to predict or forecast IC for a region, resulting from IC policies at the level of cities, for example.
Specifically, we can demonstrate that it is possible to consider the problem of expression of IC for entities at level (l+1) knowing the IC of entities at level (l), the level from which it is formed.
As an example: how to express the IC of a city (C) – Cities Intellectual Capital (CIC) – knowing the ICs (O_i, i= 1, …, n_O) from the organizations that integrate the city? Or the Region IC – RIC - from the CICs of cities that integrate the Region?

Several problems emerge when we try to answer this question. For example, what is the kind of function to use? Is the Regional Intellectual Capital (RIC) of some region, the sum of the CICs of cities that integrate the region? Or is the CIC the sum of ICs of organizations in the city?

$$\text{CIC} = \sum_{i=1}^{n_C} IC(O_i) \quad ?$$

Since the value of this expression would increase without limit, a better option could be the mean of the IC value for organizations in the city.

$$\text{CIC} = \frac{1}{n_C} \sum_{i=1}^{n_C} IC(O_i)$$

This expression does not account for important sources of IC, resulting from interactions between cities in a region or organizations in a city so fruitful in these days considering the existence of networks.
A better expression, considering yet the aggregation mode as the sum, would be:

$$\text{RIC} = \frac{1}{N_1} \sum_{i=1}^{n_C} w_i * CIC_i + \frac{1}{N_2} \sum_{i<j} w_{ij} * CIC_i * CIC_j$$

In this expression w_i are weights accounting for the importance of cities or organizations and w_{ij} (i<>j) are weights for the interaction of entities of the same level. N_1 and N_2 are normalizing constants. For example, $N_1 = n_c$ number of cities in a region and $N_2 = n_c*(n_c-1)/2$.

These expressions can be criticized on the grounds of the aggregation function (sum) and for not accounting for important relations between entities of distinct levels – for example between organizations and regions.

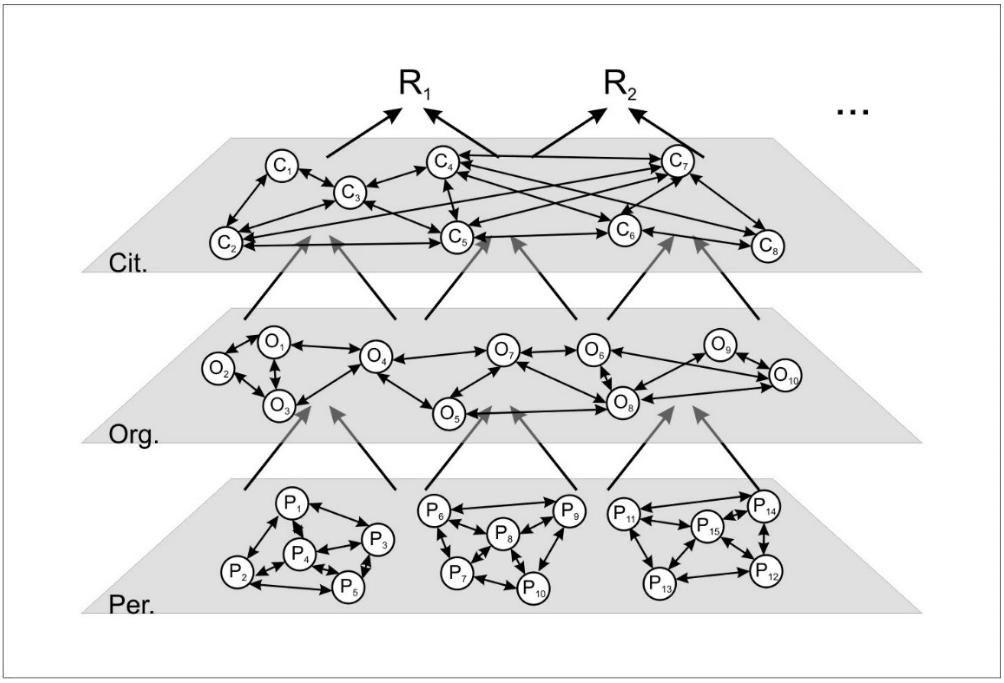

Figure 2. The relations between entities of a specific level influences the IC of entities at higher levels.
Per – People; Org – Organizations, Cit – Cities
In general, we can assume that IC (u_{l+1}) – Intellectual Capital of a unit of level l – is an non decreasing function of IC ($u_{l,j}$), j= 1, 2, …, u_l - intellectual capital of Entities at level (l), divided by (u_l) or some other normalizing constant, but the exact nature of this function is not known.

$$\mathrm{IC}(u_{l+1}) = \frac{1}{n_l} f\,(u_{l,1}, u_{l,2}, \ldots, u_{l,i})$$

In case there is enough data about RICs of a convenient number of regions (level *l*+1) and the corresponding CICs (or level *l)* then, using a data driven approach - for instance multilevel regression on other convenient data driven methodology – to try to get some insight about a convenient form of (*f*).
For our present objective, let us postulate some simplifying assumptions (see Chao, Xiao and Lingyu, 2015)

1. It makes sense to speak of IC for all kinds of entities at distinct levels.
2. The structure of the entities at each level are similar, justifying its observation by a common instrument.
3. All ICs - independent of level – are measurable by ordinal scales (from minimum IC to maximum IC) formed by relative numbers or by vectors with components of this nature.
4. The increase of IC of an entity of level *l* cannot be the cause of a reduction of IC for the entities of level *l*+1 to which it belongs.
5. The reduction of IC of an entity of level *l*+1 always implies that there was a reduction of IC for some of the entities that it integrates.

The introduction of relative numbers - is an attempt to consider the IC of entities with high IC (high potential to create value), but with objectives not aligned with the objectives of entities to which they belong. For example: in cities and regions, there are organizations that use the skills and knowledge of its members to commit crimes that have a negative effect in the global IC. This could also be one way to avoid a paradoxical situation – as the one mentioned in Vale, Castelo Branco and Ribeiro (2016) – where the increase of IC value of an organization caused an IC reduction in the organization to which it belonged.

2 - Modelling Issues

In this session of the paper, we will try to formulate a modelling methodology using as an inspiring model certain known facts about neuropsychology (See Johnson-Laird (1983, 2010), Kosslyn 2006, Damásio,2010).
As we have mentioned before in this paper, all entities for which it makes sense to speak of IC, have reasoning, learning and decision-making capabilities. This is recognized when, frequently, concepts such as smart and intelligent cities, regions and nations are used in the specialized literature not as literary and intuitive expressions but as important management concepts.
This fact, associated with the exponential development of ICTs and, in particular, with development of Internet, Social Networks, Internet of Thinks (IoT), cloud computing and phenomena of Big Data, created conditions that justify the use of concepts associated with the study of the human brain, the human mind and the nervous systems as source of sound inspiration when facing the problem of modelling the management systems as the ones we intend to develop.
For example, the definition of “smart city” given in Miorandi *et al.* (2014) means, implicitly, that it is recognized that the city has a sensorial system formed by a set of sensors – with the apparent implicit objective - almost identical with its biological

counterparts - to collect data from environment and from its internal component systems, obtaining a representation of "city body" and its processes, useful for the decision processes.
The existence of sensorial systems is not specific of cities or regions, but is common to all complex engineering systems – such as ships or aircrafts - that are nowadays equipped with thousands of sensors that monitor continuously such systems, to support operational and logistic decision processes, generating the associated phenomena of Big Data.
The present exponential development of Internet has also other important inspiring consequences for our modelling tasks.
Some social phenomena exist, almost entirely on the Internet, meaning that some important components of those processes create subnetworks and the corresponding data flows; the phenomena would not exist without that component. This means that one part of reality is now in the internet and that the right place to study those phenomena and some social illnesses is to observe the parts of internet that represent those realities. This is what happens in modern medicine when the study of some human illnesses is made, in good part – as happens with Alzheimer – observing, studying and operating the relevant parts of brain.
For our modelling tasks, we consider specially inspiring the concepts of "mental representation" in Johnson-Laird (1983), mental images in Kosslyn (1996) and the theory of development of mind (and self) out of its biological support as suggested by Damásio (2010). In particular, the so called CDZ (Convergence Divergence Zones) presented in Damásio (2010), reporting earlier work, is very inspiring when we come to create models for systems such as ours.
In other words, when solving problems about the world, human brain and mind seems to reason not directly on sensor data but on relevant representations of the reality elaborated by the brain. Since we are dealing not only with beings with reasoning and decision-making abilities, but also with comparable behaviours, it seemed to us "natural" to try to abstract from biology and neuropsychology some inspiration when trying to model systems to be used in the IC management of such entities.
In this context, we came up with the following set of "components" to be used systematically for the specification of management systems for the development of the IC of cities and regions and similar problems.

Sensors (S) – Its function is to collect data on a single aspect of reality, characterised by a single variable or a vector of components, qualitative or quantitative. Each sensor corresponds to a single data stream that will feed one or more decision–making processes. The output of sensors is data to feed the other kind of components or the other kind of sensors (more complex). The data obtained by sensors can also be stored (memory) for feature treatment.
In the context of a city or region, a sensor can be an equipment to measure, for example, the velocity of wind, the air temperature, a questionnaire to be systematically applied to capture the "mood" of citizens in relation to some political aspect or can be a person that observes some specific relevant aspect of reality and supplies systematic observation, for example, through a smartphone. The output of sensor is data.

Representation (R) – This component is an abstraction of concepts of Mental Model (Johnson-Laird, 1983) or Mental Image (Kosslyn, 1996).
It corresponds, in general, to a mathematical, pictographic or verbal representation of some relevant aspect of reality that must be managed, implemented by software.

This representation must have meaning for all involved and, being an abstraction, its characteristics must be as valid as possible of the real phenomena it represents.
The general idea is that the reasoning about the world from those involved in a specific management problem for which the representation is relevant, is made thinking not in the world but in the representation. The decisions about the world result from these reasoning processes and not from the direct observation of reality.
Technically, representation can be more or less complex and can assume the form of a single formula (for example: the law of gases relating pressure, volume and temperature - PV=RT) or complex decision rules to diagnostic illness of a human being or failure of a machine: a simulation system of weather in a certain region or the economy of that region. The general idea is that reality is replaced by its representation in the decision processes.
A valid representation, once operational, that represents dynamic knowledge about reality, is Intellectual Capital. Any representation (of reality) results from a mathematical reasoning process followed by a validation process that involves data obtained by adequate sensors and its treatment by the suitable data analysis method, performed by other kind of component called Representation Generators.

Representation Generators (RG) – These components receive sensor data and implement some specific statistical optimization or simulation tasks, transforming data into knowledge that represents some specific aspect of reality. This kind of component is an abstraction from some automatic data analysis processes that integrate human and other nervous systems and create or upgrade current representations.
As an example: the construction of a visual image by the human vision system means the conversion of light in chemical reactions whose resulting products are transformed into electrical signs on the optical nerve, originating images that support decision processes.

Memory (M) – Similarly with what happens in biological systems, this component is an abstraction for the biological nervous systems capability to store data and knowledge for future use. In the case of a digital system, the memory is fed through data bases.
As an example, we can consider the problem of IC management at the level of a region and its cities.
An important kind of reality representation is the intellectual capital map and its relations with geographic, sociological and population variables. All kinds of decisions, that involve georeferenced knowledge, can be made reasoning on a map. Before the digital era, the distinct kind of information could be mapped using clever rules and semiology – such as simple words – to present visually the information that mattered. When that was not possible in a single map, specialized versions of the same map were produced (weather, terrain, roads, clime, resources, …, cities, …).
Today, the map of a region is updated as needed using the instantaneous content of specialized data bases that can be geographically distributed and connected by Internet or other special networks (See Figure 3). It can happen that a specific (dynamic) map can be fed by inputs resulting from other representation of reality.

This kind of representation is especially suited - using data supplied by human sensors - to observe "online" the spatial and temporal emergence and evolution of social phenomena such as "the emergence of crowds", development, behaviour and extinction, crime distribution and similar phenomena.

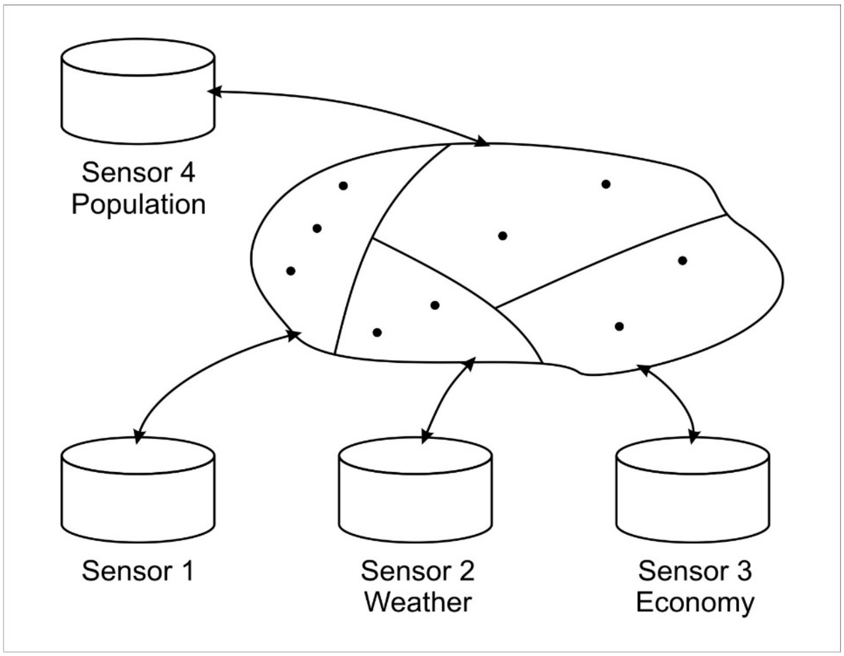

Figure 3 - A representation – Map - is dynamically updated by data supplied by sensors.

3 - Monitoring IC of Cities and Regions

Assuming IC as a strategic planning factor for the formulation of policies at distinct territorial levels – individual, organizational, cities, regions, nations – it makes sense to face the management of CICs and RICs development process and of IC monitoring as important instruments for policy formulation and evaluation. This can be achieved by a systematic mapping of IC and associated decision variables.

It is not an easy task to access and obtain knowledge about real processes of IC creation at the level of Cities and Regions and to validly acknowledge, as early as possible, its nature and potential future value for cities and regions.

In what follows, we propose a possible strategy for the specification of IC management development systems, consistent with the modelling methodology expressed in previous paragraphs.

It is assumed that CICs and RICs are functions of the behaviour – including decisions, attitude, values, products, activities – of some major players (MPs) that must be identified and characterised in each city or region, CICs and RICs, resulting in large measure from the activity and interactions from these MPs.

For a generic entity (City or RIC) there are some MPs that mean the same or approximately the same for all entities. However, for some entities, specific players can be identified. For example, for regions, generic players with similar meaning for every region could be:

a) Cultural Players: Universities, Polytechnic Schools, Research Institutes and other cultural organizations or individuals, having significant production of ideas.

b) Political Players: Political parties and other political organizations with influence in the formation of the political attitudes of citizens.

c) Religious Players: Churches and other religious organizations with a significant impact in the religious attitudes of citizens.

d) Economic Players: Commercial, Agricultural and Industrial organizations or important and influential enterprises of the region.

Those players – by what they do, by its relationships and by its importance - influence and, in some cases, determine the relevant intangibles of the region and its management. So, it is essential that they are identified and characterized in such a way that the players included in the specific study mean the same in distinct regions. For example: the concept of University is the same for all regions involved?
Those players are natural sources of IC information for the unit. This means that associated with each player there is a set of sensors supplying information related with the management of IC.
During the planning phase of the project, the distinct players to be considered (and its equivalents in each city or region) are identified and subject to a consensus before its inclusion in the study.
The study will be object of a universal methodology in order to guarantee the comparability of the data and results to be obtained.
One important source of information to be supplied by the identified players assumes the form of the answers that MPs (its representatives) supply in a systematic way with a periodicity to be defined (month, semester, year, etc.) to the questionnaire (Q1, Q2,…) constructed having in mind the need to capture, in a fixed setup, the opinions, values, suggestions, facts, events of the distinct players about distinct aspects related with the identification, creation and management of intangibles of the unit.
This systematic data collection can be operationalised through panels of experts.
These ideas are illustrated in Figure 4, with a hypothetical system to support the development and monitoring of RICs for a virtual region.

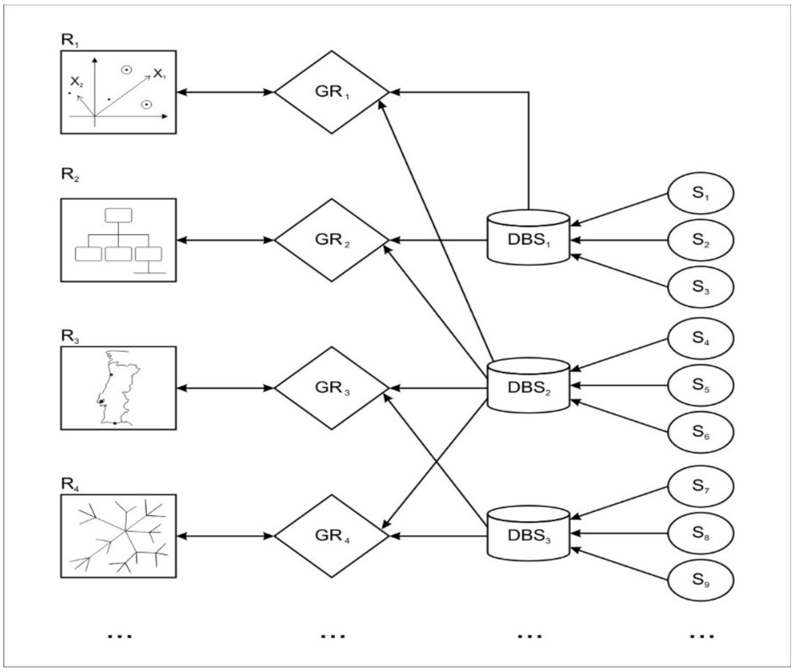

Figure 4 - Hypothetical system to support the development and monitoring of RICs for a virtual region.

R_1, R_2, R_3, R_4 are the assumed representations of the world from the point of view of RIC management.
R_1 – Representation 1 – Expressed by dynamic Biplots.
R_2 – Representation 2 – Expressed by dynamic Decision Tree.
R_3 – Representation 3 – Dynamical geographical map to display geographical distributions of variables.
R_4 – Representation 4 – Semantic map representing the public opinion, values, meanings and its inter-relations.
GR_1 – Statistical Software / Data Mining package to create and update Biplots.
GR_2 – Statistical Software / Data Mining package to create and update Decision Tree.
GR_3 – Statistical Software – for example Geographic Information System (GIS) – to create and update the spatial distributions of relevant variables.
GR_4 – Statistical Software to create and update Semantic Networks with concepts and its relations.
DBS_1, DBS_2, DBS_3 – Data Bases (Memory) containing rough data (before analysis) collected by Sensors.
S_1 – Sensor number 1 – To collect answers to Questionnaire 1, directed to managers of firms.
S_2 – Sensor number 2 – To collect answers to Questionnaire 1, directed to managers of Universities.
S_3, …, S_9 – Specialized sensors to collect data from relevant sources.

Assuming that for this specific management problem the decision process (including policy formulation) needs to know at any moment, the spatial distribution of components and nature of IC and also the relation between IC and variables that could explain its occurrence - such as population distribution, income distribution, spatial distribution of cultural activities – then, some of the following representations would be useful:

R_1 – A biplot, relating components and nature of IC with Major Players. This representation interacts with users and is created and updated by a specialized statistical or data mining software called GR_1 – Representation Generator – that transforms the data collected by relevant sensors (S_1, S_2, S_3, S_4, S_5, S_6) stored in the Memory components implemented by data bases (DBS_1, DBS_2).

R_2 – A Decision Tree that relates the attributes of IC with observed answers to questionnaires, supplied by specific players, and also with geography, population and official statistics.
This kind of representation is created and is updated by specific software (statistical software / data mining software) that receives its inputs from the data bases (DBS_1, DBS_2) where relevant sensors (S_1, S_2, S_3, S_4, S_5, S_6) store its rough data.

S_4 – Corresponds to geographic data.

S_5 – Population data.

R_3 – A dynamic geographic map where the spatial distribution of variables relevant to decision process are posted according to the needs of policy makers and other decisions makers. This maps are produced and updated – generally GIS – Geographic

Information System (GR_3) – out of geo-referenced data collected by sensors (S_4, S_5, S_6), eventually combined with other information such as Opinion Polls (S_7), Press (S_8) and Citizens' Opinions (S_9).

R_4 – A Dynamic Semantic Network, when concepts abstracted from Citizens' Opinions (S_9), News (S_8), Polls (S_7) are expressed through a graph of concepts created and updated by a specialized Representation Generator (GR_4) out of texts written or spoken collected by specific sensors.

4 - Synthesis and Conclusions

IC is a strategic planning concept at the level of firms, for which it was initially created. Its relevance for other organizations, cities, regions and nations is now generally accepted. Although there is now a large literature about the IC generalization to higher levels, the theory supporting this generalization is scarce. In this exploratory paper, we intend to contribute with the idea that the generalizations to CICs and RICs must obey to certain assumptions, in which we include the idea that IC (and its components) must be measured using scales formed by relative numbers to account the idea of alignment of objectives between an organization and the organization to which it belongs. Also, we consider the paradox that when increasing the IC from an organization, the IC from the entity to which it belongs can decrease.
In addition, the paper presents the idea that the development of CICs and RICs has important points in common with the development of nervous systems in living beings and the development of mind in human beings, being natural to be inspired by well-known concepts and theories from neuropsychology when trying to formulate a methodology for the management of CICs and RICs. This idea is obtained with the abstractions of Sensor, Representation and Representation Generator and from its biological counterparts, such as Nerves, Sensors and Mental Representation/Mental Image, using these abstractions to specify management systems in a way that allows easy expansion for such systems (inclusion of news functionalities) and modularity.

References

Bounfour, A. & Edvinsson, L. (2005). *IC for Communities, Nations, Regions, Cities and other Communities*. Elsevier, Butterworth-Heinemann, Burlington.

Cabrita, M. R. & Landeiro, V. J. (2006). Intellectual Capital and Value Creation: Evidence from Portuguese Banking Industry. *The Electronic Journal of Knowledge Management*. Volume 4 Issue 1, pp. 11-20.

Cabrita, M. R., & Cabrita, C. (2010). The Role of Creative Industries in Stimulating Intellectual Capital in Cities and Regions. In: *Proceedings of European Conference on Intellectual Capital, Lisbon, Portugal*, 29-30 March 2010.

Chao, L., Xiao, L., & Lingyu, X. (2015) The Influence of Regional Intellectual Capital on Regional Economic Development - Evidence from China. *Science and Technology*, 8(6), pp. 91-104.

Damásio, A. (2010). *Self Comes to Mind: Constructing the Conscious Brain*. Pantheon.

EU Ministers (2007). *Leipzig Charter on Sustainable European Cities*. European Union, Leipzig.

European commission, (2016), Regional Policy. Smart Regions. Available at:
European Council (2000), *Presidency Conclusions*. Available at: http://www.europarl.europa.eu/summits/lis1_en.htm (accessed 20 May 2016).

European Parliament (2014): *Mapping Smart Cities in the EU.* Available at: https://issuu.com/aie_eur_electrical_contractors/docs/ipol-itre_et_2014_507480_en (accessed 20 May 2016).

http://ec.europa.eu/regional_policy/en/policy/what/investment-policy/ (accessed 20 May 2016).

Johnson-Laird, P.N. (1983). *Mental models*. Cambridge University Press, Cambridge, England.

Johnson-Laird, P.N. (2010). Mental models and human reasoning. *Proceedings of the National Academy of Sciences of the United States of America,107:43*, 18243-18250, Available at: http://www.pnas.org/content/107/43/18243 (accessed 20 May 2016).

Kosslyn, S. M. (1996). I*mage and Brain. The Resolution of the Imagery Debate*. Bradford Books. The MIT PRESS.

Manville, C., Cochcrane, G., Cave, J,. Millard, J., Pederson, J. K., Thaamps, R. K., Liebe, A., Wissmen, M., Massink, R., & Kotlerink, B. (2014). *Mapping Smart Cities in the EU. European Parlament*. Directorate General for Internal Policies, Policy Department A: Economic and Scientific Policy. Available at: http://www.europal, europa.eu/studies (accessed 20 May 2016).
Matos F. (2014) Cities Auditing Model, *Proceedings of International Conference on Mobility and Smart Cities*, Rome, Italy, 27-29 October 2014.

Matos, F., Vairinhos V.& Rodrigues, S. (2015) Mapping The Intellectual Capital of Cities and Regions, In: *Proceedings GBATA 2015, 17th Annual International Conference of the Global Business and Technology Association,* Peniche - Portugal, Lisbon, 7 - 11 July 2015.

Miorandi, D., Matese, V., Rovatsos, M., Nijholt, A., & Stewart (2014). S*ocial Collective Intelligence.* J. Editors, Springer.

Stewart, T. A. (1997) *Intellectual Capital: The New Wealth of Organizations*, Doubleday/Currency, New York.

Vale, J., Castelo Branco, M., & Ribeiro, J. (2016). Individual Intellectual Capital Versus Collective Intellectual Capital in a Meta-Organization. *Journal of Intellectual Capital,* 17(2), pp. 279-297.