https://dx.doi.org/10.22161/ijaers.68.14 ISSN: 2349-6495(P) | 2456-1908(O)

Analysis of the European and Brazilian Rankings of Smart Cities: a case study of São José dos Campos and Toulouse

Jair Gustavo de Mello Torres, Neusa Maria de Andrade, Pedro Luiz de Oliveira Costa Neto

Paulista University, São Paulo, Brazil

Abstract— *The concept of "smart city" has become more present in academic literature and public policy in recent years, due in large part to the growing importance of cities in the global context. For the first time in history, most of the global population lives in cities. Although they represent only 2% of the world's surface, urban areas consume more than 70% of the world's total resources. As a result of rapid population growth, cities are facing challenges that lead them to seek innovative approaches to management and organization. City managers need indicators to measure performance in providing services and improving the quality of life for the population, assessing the development of local public policies and benchmarking with other cities. It should be noted that to meet this need there was an expressive appearance of city rankings, but many of them focus only on the final result and do not present a clear methodology. In addition, the availability of open, standardized and up-to-date city data is a challenge. The objective of this article is to present a comparative analysis between two rankings of smart cities: the European ranking of European Smart Cities and the Brazilian ranking Connected Smart Cities. An exploratory study was carried out with bibliographical research on the theoretical concepts of intelligent cities, rankings and measures of city performance. A case study in the cities of São José dos Campos (Brazil) and Toulouse (France) was also carried out. The present study found that the analyzed rankings show convergences in most of their indicators. The European ranking has more academic characteristics and provides a more in-depth analysis of the data of the cities, and the choice of indicators for both rankings reflects the current situation of each region analyzed with regard to its development.*

Keywords— ***Smart City, City Ranking, Quality, ISO 37120, Connected Smart Cities.***

I. INTRODUCTION

In the last two decades, the concept of "smart city" has become increasingly popular in scientific literature and international politics. To understand this concept, it is important to recognize why cities are considered key elements for the future. Cities play a major role in social and economic aspects throughout the world and have a huge impact on the environment (ALBINO, 2015).

Mccarney (2015) reports that, for the first time in history, the majority of the global population lives in cities. According to the United Nations, in 2018 an estimated 55.3% of the world's population lived in urban settlements. By 2030, urban areas are designed to house 60% of the world's people and one in three people will live in cities with at least half a million people. Understanding the major trends in urbanization that are to develop over the next few years is crucial to the implementation of the Sustainable Development Agenda 2030, including the Sustainable Development Goal 11, to make cities and human settlements inclusive, safe, resilient and sustainable (UN, 2019). Although they account for only 2% of the world's surface, urban areas consume more than 70% of total world resources (BUHRKAL, 2012). According to de Halleux (2018), the concern with "intelligence" in city management is particularly obvious in Latin America because it is one of the most urbanized regions in the world. By 2050 urbanization rates are expected to reach 90% in this region. Dealing with the local consequences of rapid population growth, cities are facing changes that lead them to find innovative approaches to management and organization. Uneven economic growth, underemployment, crime and violence, rising poverty, climate change, increasingly binding fiscal constraints, corruption, or increasing political and governance complexity are some of the most obvious challenges that municipal managers face (DE HALLEUX, 2018; MCCARNEY, 2015).

Along with this demographic shift, a new set of challenges for city leaders around the world emerges. Due to radical

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

economic and technological changes in the last decades, cities face increasing competition for investors, tourists, skilled labor or international events (BEGG, 1999). Thus, cities are challenged to introduce more strategic tools to concentrate relevant organizational capacities and identify priority strategic projects that effectively and competitively guide urban and metropolitan development (JESSOP et al., 2000; MAIER, 2000).

Gaining a comprehensive understanding of how cities can meet the challenges they face is not as simple as it may seem. Some cities can perform well in some dimensions, while doing poorly in others. One approach is to identify specific quantitative indicators for all relevant policy areas to measure performance against each dimension and at the same time highlight possible trade-offs. These indicators can be used to assess the city's performance for any specific problem. And they can also be used to produce a synthetic indicator, providing a global overview of the city's overall intelligence. Clearly, the robustness of the approach is very sensitive to the specific choice of indicators and this is linked to the availability of data (DE HALLEUX, 2018).

As one of several consequences of this, city rankings have experienced a notable boom: on the one hand, comparing cities can support investors in choosing the location; on the other hand, it can be an important guide for cities to judge their strengths and weaknesses and to define their objectives and strategies for future development and better positioning in the urban system. However, there is some evidence that the discussion of city rankings focuses mainly on the final results, totally neglecting (1) the methods and indicators used and (2) the purpose and effectiveness of strategic planning to be conquered (GIFFINGER; GUDRUN, 2010).

The earliest and best published documents on the subject were about European cities, internalizing the first insights on what drives their intelligence. There is also a more commercially oriented, but less analytically transparent, city classification produced by consulting firms. These generally have somewhat more specific measures than the more academic classifications. Unfortunately, there are few details about the analytical treatment of raw data in order to produce a detailed comparison (DE HALLEUX, 2018).

The objective of this article is to present a comparative analysis between two rankings of smart cities: the European ranking of European Smart Cities and the Brazilian ranking Connected Smart Cities. To achieve this goal, we performed an exploratory study of literature on the theoretical concepts and a case study in São José dos Campos (Brazil) and Toulouse (France), referring to local reports, federal and state agencies data.

This article is divided into six sections. The introduction is the first section, which provides an overview of the topic of the article. In the second section is made a literature review on Smart Cities and Rankings for Smart Cities. In the third section, methodological procedures are presented. In the fourth section, the results are presented and discussed. In the fifth section there is a comparative between the cities studied and, finally, the conclusions are shown in section six.

II. BACKGROUND

2.1 Smart Cities

The technological development that characterizes the last decades of economic progress of Western societies has transformed the once industrial city into a city of information and knowledge (FERNANDES & FERNANDES, 2006). According to Amoêda (2013), society ceased to live in an environment determined by the spatiality of places, and began to inhabit a place determined by the spatiality of information flows. In this sense, urban space acquires a new role in nowadays society, an intense reflection of a new economy based on the power that comes from the possession of knowledge, generally viewed as a result of access to information and the internet, observed mainly in cities (Fernandes & Fernandes, 2006).

The term emerging smart city is introduced as synonymous with a city where everything is sensitive to an environment able to produce, consume and distribute a large number of information in real time. With such a feature, this intelligent processing serves as a reference for decision-making by companies, governments and citizens, with the aim of making urban activities more efficient and sustainable in the economic, social, ecological and political spheres. Consequently, the focus is on projects that aim to make the economy, urban mobility, environment, citizens and government smarter (LEMOS, 2013).

According to Albino (2015), the term smart city was first used in the 1990s and focused on communication and information technologies, so that the city defined itself as intelligent. To Komninos (2002), smart city is a place that combines the digital environment and real community, has a high level of knowledge, belongs to a geographic area that shares the knowledge; depends on a structure based on information and communication technology (ICT) and optimizes knowledge management.

Burgos (2014) defines a connected city as an environment that has electronic communication, to establish a space of digital connection between cities and communities. A sustainable city is classified by Campos (2006) as a place that minimizes the consumption of space and natural resources, which rationalizes and efficiently manages

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

urban flows, protects the health of the urban population, ensures equal access to resources and services and maintains social and cultural diversity.

According to Giffinger (2007), there are six dimensions in a smart city: economy, mobility, governance, environment, socializing and people.

While systems in industrial cities were primarily purely physical structures, post-industrial citiesare like organisms that develop an artificial nervous system, which allows them to behave in a coordinated and intelligent way. The new intelligence of cities, therefore, lies in the increasingly effective combination of digital telecommunications networks (nerves), ubiquitously embedded intelligence (brains), sensors and tags (sensory organs), and software (knowledge and cognitive competence) (CHOURABI et al., 2012).

Based on the exploration of a wide and extensive variety of literature from various disciplinary areas, Chourabi et al. (2012) identified eight critical factors of intelligent city initiatives: management and organization, technology, governance, political context, people and communities, economy, built infrastructure and natural environment. These factors form the basis of an integrative framework that can be used to examine how local governments target smart city initiatives, as illustrated in Figure 1.

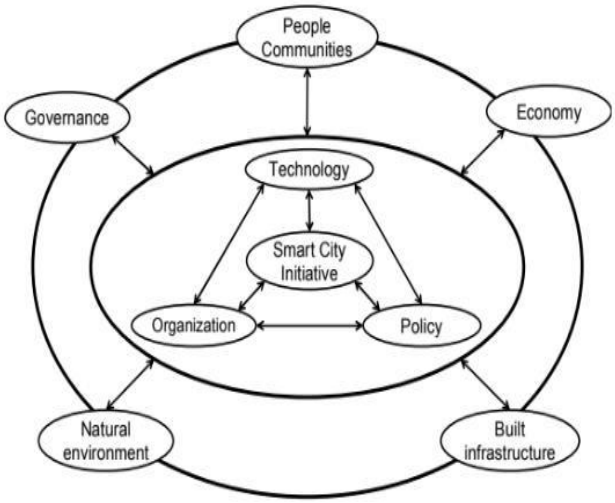

Fig.1: Structure of smart city initiatives
Source:Chourabi et al. (2012).

2.2 Rankings

As a consequence of strong economic and technological changes in the last decades, cities and regions face increasing competition for high-level economic activities. At the urban level, cities aim to improve their competitiveness and their position in relation to other cities around the world. This tendency increases the importance of specific local characteristics, which offer comparative advantages competing for multinational companies, investors, tourists and capital (GIFFINGER; GUDRUN, 2010).

To identify best practices, various tools can be identified, such as benchmarking and ranking of cities. Town classifications have become a central instrument for assessing the attractiveness of urban regions over the past 30 years. In these types of comparative studies, cities are evaluated and classified for different economic, social and geographical characteristics in order to reveal the best and worst places for certain activities (GIFFINGER et al., 2007).

As a consequence of this new trend, city rankings have experienced a remarkable growth in recent times, and so, the comparison of cities can support investors in the choice of location, on the other hand, can be an important guide for cities to analyze their strengths and weaknesses, and to set goals and strategies for future development (GIFFINGER; GUDRUN, 2010).

These authors define three distinct aspects by which a ranking can be compared and classified:

- **Objective:** it is specified by the goal of the ranking, the target public, its spatial reach and by the desired factors and indicators.
- **Methodology:** which includes not only the form of data collection and processing, but, in a first phase also to the limitation of the cities examined in the ranking. The availability of data for the ranking also plays an important role in the selection of cities if resources are limited.
- **Dissemination:** how the results are evaluated, interpreted and presented is crucial to the impact of the ranking. A general list of classified cities is the typical result of city classifications, but some studies also include more differentiated results. Another aspect of the disclosure is the final availability of results. The general city list is available for free. Partial results, interpretations and deeper insights are often not available for free.

Giffinger and Gudrun (2010) also establish four types of city rankings:

- **Type 1:** consultancy-oriented rankings with lack of transparency and documentation;
- **Type 2:** contracted rankings with insufficient transparency created by panels of experts or other private research institutes. A list of indicators is published, but rankings rarely provide information on the method of calculation. Sponsors of these rankings are financial institutions, magazines or real estate agencies;
- **Type 3:** rankings compiled by magazines or NGOs (non-governmental organization) without sponsorship;

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

- **Type 4:** well documented and methodically advanced rankings by universities or research institutes with sponsors in different areas (financial institutions, magazines, real estate agencies, etc.).

Thus, according to Giffinger and Gudrun (2010), the constituent elements of a city ranking require that at least two cities be included, the structuring of cities is in an ascending / descending order arranged in a hierarchy and the use of at least two indicators to build the order or hierarchy.

For Giffinger et al. (2007), as benefits, rankings attract attention in general and draw attention to regional science issues. The dissemination of the results of a new ranking encourages a broad discussion on regional development strategies. Rankings are also a competitive tool as the positive characteristics of cities are made public.

City rankings can also initiate learning effects, since regional actors are required to make their decisions transparent and understandable (GIFFINGER; GUDRUN, 2010).

As limitations, Giffinger et al. (2007) consider that the discussion of city classification results generally focuses on the final classifications and, consequently, the analysis of complex interrelationships and causalities are neglected. The attention of the public is mainly focused on the final ranking, without considering the methodological aspects behind the classifications, which can be observed in the conception of many rankings.

From a more strategic point of view, city rankings can threaten long-term development strategies as rankings strengthen competition between cities, what may have negative consequences, such as deregulation, structural and spatial problems, the risk of socially unacceptable urban development, etc. Moreover, the narrow treatment of ranking results is counterproductive to balanced city development strategies, as rankings are overly acclaimed by "winners" and ignored by "losers." In addition, cities (mostly poorly ranked cities) are opposed to comparisons with others, and rankings tend to follow a generalist approach, as many funders seek clear results, which can easily be reported in public, and therefore, most of the classifications aim to find the city better or more attractive, totally ignoring the fact that diverse activities need different conditions (GIFFINGER; GUDRUN, 2010).

2.3 Measures of Performance

Different measurement methods and indexes have been developed up to now according to the various meanings of the concept of smart city. Classification systems through synthetic quantitative indicators are receiving increasing attention among municipal managers and policy makers to decide where to focus time and resources as well as to communicate city performance to citizens, visitors and investors (BERARDI, 2013a, 2013b). According to Albino (2015) one of the values of these systems is the ability to represent a comparison metric, which surpasses the self-proclamations of being an smart city.

The University of Vienna developed an evaluation metric to classify 70 European medium-sized cities (Giffinger et al., 2007). This metric uses specific metrics for each of the six identified dimensions of a smart city.

Another evaluation system was developed by the Intelligent Community Forum, which annually announces award-winning cities such as Smart 21 Communities. This metric is based on five factors: broadband connectivity, a skilled workforce, innovation and marketing,digital inclusion and advocacy (ALBINO, 2015).

Zygiaris (2013) developed a measurement system, identifying six layers of an intelligent city: the city layer, emphasizing that notions of smart cities should be based on the context of a city; the green layer of the city, inspired by new theories of urbanization of urban environmental sustainability; the interconnection layer, corresponding to the diffusion of green economies throughout the city; the instrumentation layer, emphasizing that smart cities require real-time system responses made by smart meters and infrastructure sensors; the open integration layer, noting that smart cities applications must be able to communicate and share data, content, services and information; the application layer, useful for smart cities to mirror the city's operations in real-time into new levels of intelligently responsive operation; and the innovation layer, emphasizing that smart cities create a fertile innovation environment for new business opportunities.

A methodology for assessing "the smart city index" was proposed by Lazaroiu and Roscia (2012). The index helped to distribute European funds in the 2020 strategic plan. The indicators that contributed to this index are not homogenous and require a great deal of information. The problem of information availability and the difficulty in assigning weights to add the indicators considered are among the limits of this method. The proposed approach uses a fuzzy procedure that allows to define a set of weights to combine the different indicators according to their relative importance.

A more sophisticated system for measuring the intelligence of a city was proposed by Lombardi et al. (2012). These authors used a modified version of the triple helix model, a framework for analyzing knowledge-based innovation systems that links the three main knowledge creation agencies: universities, industry and government (Leydesdorff and Deakin, 2011). The authors added a new

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

agent of knowledge creation to the previous three, the civil society, determining a model of four propellers. For each of the four innovation drivers, they propose indicators of an intelligent city according to five clusters (Lombardi et al., 2012). This analytical framework is composed of 60 selected indicators following a literature review which included EU (European Union) project reports, Urban Audit data set, European Commission statistics, European Green Cities Index, TISSUE, Trends and Indicators for Monitoring the EU Thematic Strategy on Sustainability. Development of the Urban Environment and the ranking of smart cities of the European average cities. Surprisingly, they excluded the dimension of intelligent mobility (Lombardi et al., 2012).

Table 1 presents the complete list of indicators proposed by Lombardi et al. (2012) and Lazaroiu and Roscia (2012).

Table 1: List of indicators for evaluation of smart cities in some classification systems.

Source	Number of indicators	Indicators of a smart city
Lombardi et al. (2012)	60	**Smart economy:**Public expenditure on R&D, Public expenditure on education, GDP per capita of the population of the city, Unemployment rate. **Smart people:** Percentage of population with secondary education, Foreign language skills, Participation in lifelong learning, Individual level of computer skills, Patent applications per inhabitant. **Intelligent governance:** number of universities and research centers in the city, e-Government online availability, percentage of households with Internet access at home, e-government use by people. **Environment:** ambition of CO_2 emission reduction strategy, efficient use of electricity, efficient use of water, green space area, greenhouse gas emission, intensity of energy consumption, policies to contain urban sprawl, proportion of recycled waste. **Intelligent life:** Proportion of area for recreational sports and leisure use, Number of public libraries, Total loans and other means of communication, Visits to museums, Cinema and theater attendance.
Lazaroiu and Roscia (2012)	18	Pollution, Innovative spirits, CO_2, Transparent governance, Sustainable resources management, Educational facilities, Health conditions, Sustainable and innovative public transport, Pedestrian areas, Cycle routes, Green areas, Solid urban waste generation, Domestic GWh, Fuels, Strategies policies and perspectives, Availability of ICT infrastructure, Labor market flexibility.

Carli et al. (2013) have recently proposed a framework for analyzing and comparing measurement systems for smart cities. They suggest dividing measurement indicators into two categories: objective and subjective, and considering physical infrastructures and context data, along with citizens' satisfaction and well-being perception. These authors also focused on how indicators are measured and revealed that, along with traditional tools, new indicators of well-being are increasingly assessed through the detection of real-time data such as social networking messages.

The world of international standards has only recently begun to address the need for standardization in cities. International standardization bodies, such as the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO) and the International Telecommunication Union (ITU) have begun to address the urgent agenda of cities with new jobs, from smart grids to infrastructure, to international telecommunication and management systems. As part of a new series of international standards is being developed for a holistic and integrated approach to sustainable development and resilience in the committee ISO TC268 - Sustainable Community Development, and a new international standard was published on May 15, 2014 by ISO, ISO 37120 Sustainable Community Development - Indicators for Municipal Services and Quality of Life (MCCARNEY, 2015).

This new international standard has been developed using the Global City Indicators Facility (GCIF) framework and

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

includes a comprehensive set of 100 indicators, of which 46 are required for compliance, that measure the social, economic and environmental performance of a city. ISO 37120 is now part of a new series of International Standards that is being developed for a holistic and integrated approach to sustainable development and resilience. The 100 indicators with definitions and methodologies published in ISO 37120 are divided into 17 themes shown in Table 2 that represent the main areas of performance management in city services and quality of life (MCCARNEY, 2015).

Table 2 - Schematic Themes for ISO 37120

Economy	Safety
Education	Shelter
Energy	Solid waste
Environment	Telecommunications and innovation
Finance	Transport
Fire and Emergency Response	Urban planning
Governance	Residual waters
Health	Water and sanitation
Recreation	

The World Council on City Data (WCCD) portal is available with data from all cities that adhere to ISO 37120 and is motivated to provide cities with a reliable database of globally standardized data that will assist in the development of basic knowledge for decision making through global comparisons (WWCD, 2017).

In Brazil, the Brazilian Network of Intelligent and Human Cities (RBCIH) initiative is dedicated to the creation of the Brazilian Index of Intelligent and Human Cities and the Certifying Seal, with indicators that reflect whether the municipality is following the step-by-step list of actions with ISO 37120 (RBCIH, 2017) as the basis.

In addition, a key initiative of the European Commission (EC) EUROCITIES called CITYkeys (citykeys-project.eu), a project funded by the HORIZONTE 2020 program, aims to develop valid performance measurement frameworks, key performance indicators (KPIs) and standardized data collection to accelerate the diffusion of intelligent city solutions by supporting comparable, scalable and replicable smart city solutions (BOSCH et al., 2017).

Albino (2015) points out that many classifications are currently used to determine the intelligence of cities in terms of comparing practices with other cities. The Global Power City Index was created by the Japanese Institute of Urban Strategies, and is based on a collection of observed data, complemented with information on the perception of various stakeholders. This index maps the strengths and weaknesses of cities and classifies them into a broadly-based comparative analysis, according to their broad socioeconomic potential to attract creative people and excellent companies. Meanwhile, in the United States, the Natural Resources Defense Council has developed the Intelligent Cities Ranking, which is characterized by a strong bias towards environmental criteria. Forbes, with the support of scientist Joel Kotkin, has published a list of the world's smartest cities. This ranking considers a city that is compact and efficient and provides favorable economic conditions. Considering that this ranking encourages the city to be an economic pole, an international trade and a global city, it is not surprising that Singapore was considered the smartest city in that ranking. Urban classifications, such as the IBM Smart City or McKinsey Global Institute classifications, periodically compare and classify areas.

III. METHODOLOGY

The study is considered to be exploratory descriptive (GIL, 2002) and seeks to analyze two rankings of intelligent cities in order to identify convergence between indicators. Initially, the concepts of smart cities and rankings are defined. The present work analyzed one of the best known rankings dedicated to classifying smart cities, European Smart Cities, and also the best-known Brazilian ranking of smart cities, the Connected Smart Cities, in order to understand each dimension and indicator considered by these rankings.

Thus, the relationships between the rankings was studied and two cities were chosen to compare their classifications according to each ranking. The chosen cities were São José dos Campos in Brazil and Toulouse in France because both are similar in various aspects, in particular for having as their main industrial activity the aeronautical. The analyses were carried out in a qualitative way, organizing the indicators of the rankings with the purpose of identifying similar measures in the same set of analysis.

IV. RESULTS

4.1 European Smart Cities Ranking

Through a collaborative work between the Regional Science Center of the Vienna University of Technology, the Department of Geography of the University of Ljubljana and the Research Institute for Housing, Urban Planning and Mobility Studies of the Delft University of Technology, a methodology to verify the performance of cities (GASPAR; AZEVEDO; TEIXEIRA, 2016).

Given the variety of rankings, the group studied the basic characteristics of national and international rankings, such

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

as indicators, evaluation methods and potential benefits, and developed the ranking itself, the European Smart Cities. The purpose of this initiative is to show the characteristics of cities as a basis for strategic discussion, showing that rankings are a significant and efficient tool for economic, social and city processes (FLORES; TEIXEIRA, 2017).

Giffinger and Gudrun (2010) explain that the approach of the European Smart Cities ranking was developed according to the following objectives:

1. Transparent classification of a selected group of cities;
2. Elaboration and illustration of characteristics and profiles specific to each city;
3. Encouraging benchmarking among selected cities;
4. Identification of strengths and weaknesses for strategic discussion and policy orientation.

This classification approach was published in 2007 (Giffinger, et al., 2010) and explicitly addresses to medium-sized cities in Europe, taking into account their perspectives and development challenges. Basically, midsize cities, which have to deal with competition from large metropolises on corresponding issues, appear to be less well-equipped in terms of critical mass, resources and organizational capacity. Even though the vast majority of the urban population lives in such cities, the main focus of urban research has been on "global" metropolises, neglecting the importance and specific challenges of medium-sized cities.

To implement this approach, the European Smart Cities ranking considers a smart city as one that operates in six key urban development domains, built on the "smart" combination of self-determined, independent and conscious citizens' donations and activities.

According to Giffinger and Gudrun (2010), through consultation of specialized literature and a round table, the six "intelligent" relevant identified characteristics are: economy, people, governance, mobility, environment and life. These six characteristics, or key fields, were considered as the relevant group that characterizes an intelligent city. They can be broken down into 31 factors that reflect the most important aspects of all smart features. Finally, each factor of an intelligent characteristic was defined empirically through a group of corresponding indicators. In total, 74 indicators were defined and used to operationalize and aggregate the relevant factors. Figure 2 shows this description of Smart City and Table 3 presents the list of characteristics, factors and indicators for the European Smart Cities ranking.

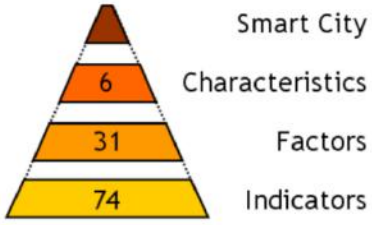

Fig.2: Description of Smart City

Source: http://www.smart-cities.eu/?cid=2&ver=3

Table 3. List of domains and components

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

	Factor	Indicator
Smart Economy	Innovative spirit	R&D expenditure in % of GDP
	Innovative spirit	Employment rate in knowledge-intensive sectors
	Innovative spirit	Patent applications per inhabitant
	Entrepreneurship	Self-employment rate
	Entrepreneurship	New businesses registered
	Economic image and trademarks	Importance as decision-making centre (HQ etc.)
	Productivity	GDP per employed person
	Flexibility of labour market	Unemployment rate
	Flexibility of labour market	Proportion in part-time employment
	Internationalembeddedness	Companies with HQ in the city quoted on national stock market
	Internationalembeddedness	Air transport of passengers
	Internationalembeddedness	Air transport of freight
Smart People	Level ofqualification	Importance as knowledge centre (top research centres,top universities etc.)
	Level ofqualification	Population qualified at levels 5-6 ISCED
	Level ofqualification	Foreign language skills
	Affinity to lifelong learning	Book loans per resident
	Affinity to lifelong learning	Participation in life-long-learning in %
	Affinity to lifelong learning	Participation in language courses
	Social and ethnic plurality	Share of foreigners
	Social and ethnic plurality	Share of nationals born abroad
	Flexibility	Perception of getting a new job
	Creativity	Share of people working in creative industries
	Cosmopolitanism/ Open-mindedness	Voters turnout at European elections
	Cosmopolitanism/ Open-mindedness	Immigration-friendly environment (attitude towards immigration)
	Cosmopolitanism/ Open-mindedness	Knowledge about the EU
	Participation in public life	Voters turnout at city elections
	Participation in public life	Participation in voluntary work
Smart Governance	Participation indecision-making	City representatives per resident
	Participation indecision-making	Political activity of inhabitants
	Participation indecision-making	Importance of politics for inhabitants
	Participation indecision-making	Share of female city representatives
	Public and socialservices	Expenditure of the municipal per resident in PPS
	Public and socialservices	Share of children in day care
	Public and socialservices	Satisfaction with quality of schools
	Transparentgovernance	Satisfaction with transparency of bureaucracy
	Transparentgovernance	Satisfaction with fight against corruption
Smart Mobility	Localaccessibility	Public transport network per inhabitant
	Localaccessibility	Satisfaction with access to public transport
	Localaccessibility	Satisfaction with quality of public transport
	(Inter-)nationalaccessibility	International accessibility
	Availability of ICT-infrastructure	Computers in households
	Availability of ICT-infrastructure	Broadband internet access in households
	Sustainable, innovative and safe transport systems	Green mobility share (non-motorized individual traffic)
	Sustainable, innovative and safe transport systems	Traffic safety

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

	Sustainable, innovative and safe transport systems	Use of economical cars
SmartEnviroment	Attractivity of natural conditions	Sunshine hours
	Attractivity of natural conditions	Green space share
	Pollution	Summer smog (Ozon)
	Pollution	Particulate matter
	Pollution	Fatal chronic lower respiratory diseases per inhabitant
	Environmental protection	Individual efforts on protecting nature
	Environmental protection	Opinion on nature protection
	Sustainable resource management	Efficient use of water (use per GDP)
	Sustainable resource management	Efficient use of electricity (use per GDP)
Smart Living	Cultural facilities	Cinema attendance per inhabitant
	Cultural facilities	Museums visits per inhabitant
	Cultural facilities	Theatre attendance per inhabitant
	Health conditions	Life expectancy
	Health conditions	Hospital beds per inhabitant
	Health conditions	Doctors per inhabitant
	Health conditions	Satisfaction with quality of health system
	Individual safety	Crime rate
	Individual safety	Death rate by assault
	Individual safety	Satisfaction with personal safety
	Housing quality	Share of housing fulfilling minimal standards
	Housing quality	Average living area per inhabitant
	Housing quality	Satisfaction with personal housing situation
	Educationfacilities	Students per inhabitant
	Educationfacilities	Satisfaction with access to educational system
	Educationfacilities	Satisfaction with quality of educational system
	Touristic attractivity	Importance as tourist location (overnights, sights)
	Touristic attractivity	Overnights per year per resident
	Social cohesion	Perception on personal risk of poverty
	Social cohesion	Poverty rate

Source: http://www.smart-cities.eu/?cid=2&ver=3

According to Giffinger and Gudrun (2010), questions concerning the criteria for city selection as well as the aggregation procedure were treated from a methodological point of view: to make the classification approach more transparent, to define the sample of cities is essential. For the European Smart Cities (2007) ranking, a viable sample was defined according to two criteria: cities should be medium size and should be covered by accessible and relevant databases. The most comprehensive list of cities in Europe is provided by the Espon 1.1.1 project. It covers almost 1,600 cities in the Espon space (EU27 + NO + CH) with information on population and some functional data. According to Dühr (2005), the ESPON 1.1.1 project on "Potentials for polycentric development in Europe", based on the definition of the European Spatial Development Perspective (ESDP), aims to provide a basis for a more enlightened discussion of polycentric development in Europe . In order to support the analysis of the level and potential of polycentric development in Europe, the report identifies two complementary aspects of polycentricity: morphology (ie distribution of urban areas in a given territory); and relations between urban areas (ie networks of flows and cooperation). The concept of polycentric and balanced spatial development of European territory has been promoted. The ESDP presented policy options to strengthen areas of global economic integration, support a polycentric system of metropolitan regions, urban settlements and urban networks through closer co-operation between structural and transport policy, and encouraging co-operation on topics space development through cross-border and transnational networks. The concept of polycentricity in ESDP is thus used as a guiding principle to achieve two arguably contradictory objectives: to strengthen the EU's economic competitiveness on the

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

world market and to achieve better social cohesion in the EU by reducing regional disparities.

For these reasons, criteria were developed based on these 1,600 cities:

- Urban population between 100,000 and 500,000 (to obtain medium-sized cities);
- At least one University (to exclude cities with a low knowledge base);
- Capture area of less than 1,500,000 inhabitants (to exclude cities that are influenced by a larger city);

In addition, the fact that a city is covered by the Urban Audit database, an European city database is decisive for benchmarking, as for reasons of data availability. Thus, 94 cities remained and, after a later adaptation and elaboration of the cities and accessibility and data quality, 70 cities were chosen for the sample.

To compare the different indicators, it is necessary to standardize the values. A method to standardize is by z-transformation, as shown in Figure 3. This method transforms all values of the indicators into standardized values with a mean of "0" and a standard deviation "1", with the advantage of considering heterogeneity within the groups and keep their metric information. In addition, a high sensitivity to change is achieved.

Expression (a). Z-transformation

$$Z_i = \frac{X_i - \bar{X}}{S} \qquad \text{(a)}$$

Source: http://www.smart-cities.eu/?cid=2&ver=3

According to Giffinger and Gudrun (2010), the results were disseminated through two activities: (1) a press conference organized at the EXPO REAL International Fair in Munich, Germany, in 2007; (2) an own internet site made available (http://www.smart-cities.eu/).

4.2 Connected Smart Cities Ranking

As a new strategy model, the smart city has a number of concepts, from the ones that are most supported in technology, to those that are more related to the environment and sustainability. Given this framework, was developed by Urban Systems, a company that offers strategic and competitive solutions that support the decision-making process and the planning of real estate projects, in partnership with Sator, the company that organizes the eponymous event, the ranking named Connected Smart Cities, with the objective of mapping the cities with the greatest potential for development in Brazil through indicators that portray intelligence, connection and sustainability (GASPAR; AZEVEDO; TEIXEIRA, 2016).

Thus, for the elaboration of the Connected Smart Cities Ranking were considered (CONNECTED SMART CITIES, 2018):

- The concept of connectivity as the relationship between the various sectors analyzed;
- The concept of Smart City considering that development is only achieved when the city's development agents understand the power of connectivity across all sectors;
- Awareness that investments in sanitation are linked not only to environmental gains, but also to health gains, which will in the long term reduce investments in the area (basic health care), consequently impact on governance issues and even economy;
- The importance of education, not only as basic indices of service and quality of teaching, but the power it has in the formation and reproduction of the potential of each city;
- The understanding of local and regional potential allows the attraction of investors and the creation of courses linked to the productive chains of the region, which will have repercussions in attracting companies and expanding clusters, as well as enabling an improvement in the social condition, which will have an impact on all other sectors;
- The importance of economic sustainability as the basis of environmental and social sustainability, since it is understood that it is not possible for municipalities to achieve environmental or social sustainability without the basis of an economic development that will guarantee a reproduction of the gains in other spheres.

Therefore, a union was established among service companies and leading technology, specialists, city halls and people engaged in the optimization of cities in Brazil, with the objective of promoting discussion, information exchange and the diffusion of ideas between government and companies focusing on meeting the needs of the conscious citizen, aiming that the Brazilian cities can become more intelligent and connected, and so that in the next 10 years it is possible that they increase the scale of their development, approaching the indexes of the models of the smart cities of the world, to seek inspiration in solutions implanted in those considered as more intelligent (GASPAR; AZEVEDO; TEIXEIRA, 2016).

For the creation of the Connected Smart Cities ranking, teams from Urban Systems and Sator mapped the main international and national publications on smart cities, connected cities, sustainable cities and other related issues in 2014, among them: "Sustainable Cities, Sustainable Cities Program"; "Brazil Transparency Scale, General Comptroller of the Union"; "Brazil Competitiveness Profile, Getúlio Vargas Foundation"; "IESE Cities in Motion, IESE Business School"; "Innovation Cities, Innovation Cities Program"; "Biggest and Best Cities in

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

Brazil"; "Smart Cities Mapping in the European Union"; "ARCADIS Sustainable Cities Index, Yale Center for Environmental Law & Policy" (CONNECTED SMART CITIES, 2018).

Because of the breadth of information and connectivity between the sectors covered in the Connected Smart Cities ranking, the indicators used were designed and studied to meet the principle of a smart city being one that grows in a planned way through analysis of the development of 11 sectors, which are: Mobility, Urbanism, Environment, Energy, Technology and Innovation, Economy, Education, Health, Safety, Entrepreneurship and Governance. Table 4 presents each sector and its respective function (CONNECTED SMART CITIES, 2018).

Table.4. Sectors and Indicators of the Connected Smart Cities Ranking

MOBILITY	URBANISM
Proportion of cars per inhabitant Ratio of car per bus Average age of vehicle fleet Other modes of collective transport Bicycle paths Wheelchair ramp No. of weekly flights Road transport	Law on zoning or land use and occupation Law on consortium urban operation Municipal strategic master plan law Issuance of negative debit certificate and permit on the city's website Paved roads Municipal expenditure with urban planning
ENVIRONMENT	ENERGY
Index of urban water service Stopping supply Index of losses in water distribution Urban sewage service index Urban sewage treatment Recovery rate of recyclable materials Rate of coverage of the domestic waste collection service Afforestation Monitoring of risk areas	Average rate Households with existence of electricity from another source other than distribution company Power generation in wind power plants Energy production in UFV (Photovoltaic Solar Generating Center) plants Energy production in biomass plants Street lighting Households with existence of electric energy
TECHNOLOGY AND INOVATION	EDUCATION
Broadband connections with more than 34 Mb Municipalities with fiber optic backhaul 4G Coverage Workers with higher education Accesses in the multimedia communication service Patents CNPQ (National Council for Scientific and Technological Development) Scholarships	Online school enrollment Public university jobs Note ENEM Teachers with higher education IDEB - final years Abandonment rate Average class size per class Municipal Expenditure with Education Average daily class time
HEALTH	SAFETY
Beds by inhabitants Doctors by inhabitants Population coverage of the family health team Municipal health expenditure Child mortality	Homicides Traffic-accidents Municipal Expenditures with Security Police officers, municipal civil guards and transit agents
ENTREPRENEURSHIP	ECONOMY
New technology companies Technological poles Growth of creative economy companies Incubators Micro individual companies - MEI Sebrae	GDP per capita Average income of workers Business growth Growth of formal jobs Independent public sector jobs Employability

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

	Non-Revenue from Transfers
GOVERNANCE	
Education of the mayor FIRJAN Municipal Development Index Brazil Transparent Scale City Councils	

Source: Connected Smart Cities (2018)

In addition to the Connected Smart Cities ranking, with the best cities in the 70 indicators, thematic rankings are generated for each of the 11 sectors covered. In order to present a regionalization of the results, the best ones are also presented by geographic region: North, Northeast, Midwest, Southeast and South. Also, city rankings by size are presented so that cities can be inspired by actions existing in municipalities of the same size, evidencing that many actions that lead to the best performance of a city are not tied to its economic power. The cut presented is: cities up to 100 thousand inhabitants; cities of 100 to 500 thousand inhabitants and cities of more than 500 thousand inhabitants. The Connected Smart Cities ranking is made up of 100 cities, while the industry rankings show results up to the 50th position (CONNECTED SMART CITIES, 2018).

4.3 Relationship between rankings

Considering the dimensions of the smart cities analyzed by the rankings, it is observed that the European Smart Cities presents six characteristics, all with the prefix "Smart": Economy, Mobility, Environment, People, Living and Governance. The Connected Smart Cities ranking analyzes 11 characteristics (sectors), which are: Mobility, Urbanism, Environment, Energy, Technology and Innovation, Economy, Education, Health, Safety, Entrepreneurship and Governance. The dimensions of the two rankings are aligned with the major smart cities definitions found in the literature.

When the indicators of the two rankings are analyzed, the number is very close. The European Smart Cities ranking has 74 indicators and the Connected Smart Cities ranking has 71 indicators. Even while analyzing fewer features of an intelligent city (six), the European ranking has three more indicators. Table 5 illustrates the comparative analysis of the European Smart Cities and Connected Smart Cities rankings.

Table 5. Comparative analysis of rankings

Analysis	European Smart Cities	Connected Smart Cities
RankingProposal	Transparent classification of a selected group of cities; Elaboration and illustration of characteristics and profiles specific to each city; Encouraging benchmarking among selected cities; Identification of strengths and weaknesses for strategic discussion and policy orientation.	Map the cities with the greatest potential for development in Brazil through indicators that portray intelligence, connection and sustainability.
Dimensions	Economy, People, Governance, Mobility, Environment and Life.	Mobility, Urbanism, Environment, Energy, Technology and Innovation, Economy, Education, Health, Safety, Entrepreneurship and Governance.
Indicators	74	70
Number of cities analyzed	70	More than 500
Release year	2007	2015
Methodology disclosed	Yes	No
Means of Disclosure	Fair and website	Fair and website
Typology	Type 4	Type 2

Source: prepared by the authors.

https://dx.doi.org/10.22161/ijaers.68.14 ISSN: 2349-6495(P) | 2456-1908(O)

In the analysis of the convergences, Table 6 presents the comparison between the indicators that present similar data in their compositions. This table lists only the indicators that have a more direct relationship. The analysis showed that there is no correlation between the analyzed indicators of the characteristics of the European ranking and the indicators of the Education, Urbanism and Energy sectors, analyzed by the national ranking. In the Education sector, the indicators refer to data that makes sense only in the Brazilian context. In the Urbanism and Energy sector there is no correlation of indicators in the European ranking. That is, the Brazilian ranking brings indicators of areas not included in the European ranking.

Table 6. Comparative analysis of indicators

European Smart Cities		**Connected Smart Cities**	
Characteristic	**Factor**	**Indicators**	**Sectors**
Smart Economy (Competitiveness)	Innovative spirit	New technology companies	Entrepreneurship
		Technological Poles	
		Growth Companies of Creative Economy	
		Incubators	
		Patents	Technology and inovation
		CNPQ scholarship	
	Entrepreneurship	Micro Single Companies - MEI	Entrepreneurship
		Business Growth	Economy
	Productivity	GDP per capita	
		Average Income of Workers	
	Flexibility of the labor market	Growth formal jobs	
		Employability	
Smart people (social and human capital)	Level of qualification	Workers with higher education	Technology and inovation
Smart Governance (Participation)	Participation in decision-making	Local Councils	Governance
	Transparent governance	TBS -Transparent Brazil Scale	
	Public and social services	Municipal Expenditures with Safety	Safety
		Municipal Health Expenditure	Health
		Municipal Expenditure with Education	Education
Smart Mobility (Transport and ICT)	Local Accessibility	Proportion of buses per car	Mobility and Accessibility
		Middle Ages Fleet	
		Proportion of cars per inhabitant	
	(Inter-)national accessibility	Number of weekly flights (connectivity)	
	Sustainable, innovative and safe transport systems	Bicycle paths	
	Availability of ICT infrastructure	Broadband Connections with + 34 mb	Technology and inovation
		Municipalities with Fiber Optic Backhaul	
		Cobertura 4G	
		Multimedia Communication Service Access	
Smart Environment (Natural Resources)	Attractivity of natural conditions	Afforestation	Environment
		Energy Production in UFV Power Plants	

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

	Sustainable Resource Management	Urban water service	
		Losses in distribution	
		Urban sewage service	
		Stopping supply	
		Urban sewage treatment	
Smart Living (Quality of Life)	Health conditions	Beds by Inhabitants	Health
		Doctors by inhabitants	
	Individual safety	Homicide	Safety

Source: prepared by the authors.

The sectors of a smart city analyzed by the Connected Smart Cities ranking have a breakdown greater than the European ranking for this reason more than one analyzed by the brazilian ranking sector is included within a feature of smart city considered by the European ranking. Of particular note is the "Technology and Innovation" sector, which is related to the characteristics "Intelligent Economy" and "Intelligent Mobility". Table 7 presents the relationship between the dimensions of the intelligent city analyzed by each of the rankings.

Table 7. Comparative analysis of the dimensions of an intelligent city

European Smart Cities	**Connected Smart Cities**
Characteristics	**Sector**
Smart Economy (Competitiveness)	Economy
	Entrepreneurship
	Technology and Inovation
Smart people (Social and Human capital)	Education
Smart Governance (Participation)	Governance
	Urbanism
Smart Mobility (Transport and ICT)	Mobility and Accessibility
	Technology and Inovation
Smart Environment (Natural Resources)	Environment
	Energy
Smart Living (Quality of Life)	Health
	Safety

Source: prepared by the authors.

V. CITY COMPARISON

Over the last four decades, regions such as the Silicon Valley in the United States, Sophia-Antipolis and the Grenoble and Toulouse complexes in France, and Tsukuba in Japan have emerged that spontaneously or from state planning as constituting spaces of scientific research, technological innovation and industrial development. In the same period, due to state incentives, in the region of Paraíba River Valley, especially in the city of São José dos Campos, structures were created that are characteristic of technological poles. Studies by the Institute of Applied Economic Research (IPEA) compared São José dos Campos to cities such as Seattle, in the United States, and Toulouse, France, in terms of the level of regional and international projection they have due to their productive specialization, coincidently "aeronautical poles" and to the level of influence they exert on places located beyond the limits of their geographic domains (SOUZA; COSTA, 2012).

5.1 São José dos Campos

The municipality of São José dos Campos integrates Sub-Region 1 of the Metropolitan Region of the Paraiba Valley and North Coast (MRPVNC). According to the Brazilian Institute of Geography and Statistics (IBGE), the estimated population of the municipality in 2018 is around 713,943 inhabitants. The territorial data show a population density of 649.39 inhab / km² and an area of 1,099,409 km² (IBGE, 2018).

The MRPVNC was created in 2012 and is made up of 39 municipalities, divided into five sub-regions. Extensive, the region concentrates 2.5 million inhabitants, according to IBGE estimates for 2017. The MRPVNC is located between the two most important Metropolitan Regions of the country: São Paulo and Rio de Janeiro. It stands out

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

nationally for intense and diversified economic activity. Industrial production is highly developed, with the automotive, aeronautical, aerospace and military sectors predominating in the municipalities located along the axis of the Presidente Dutra Highway. Also noteworthy are the port and oil activities in the North Coast and tourism in the Serra da Mantiqueira, coast and historic cities. The region is also characterized by important environmental heritage of national relevance, such as the Mantiqueira, Bocaina and Mar Sierras, and farms of historical and architectural value (EMPLASA, 2018). Figure 3 shows the MRPVNC.

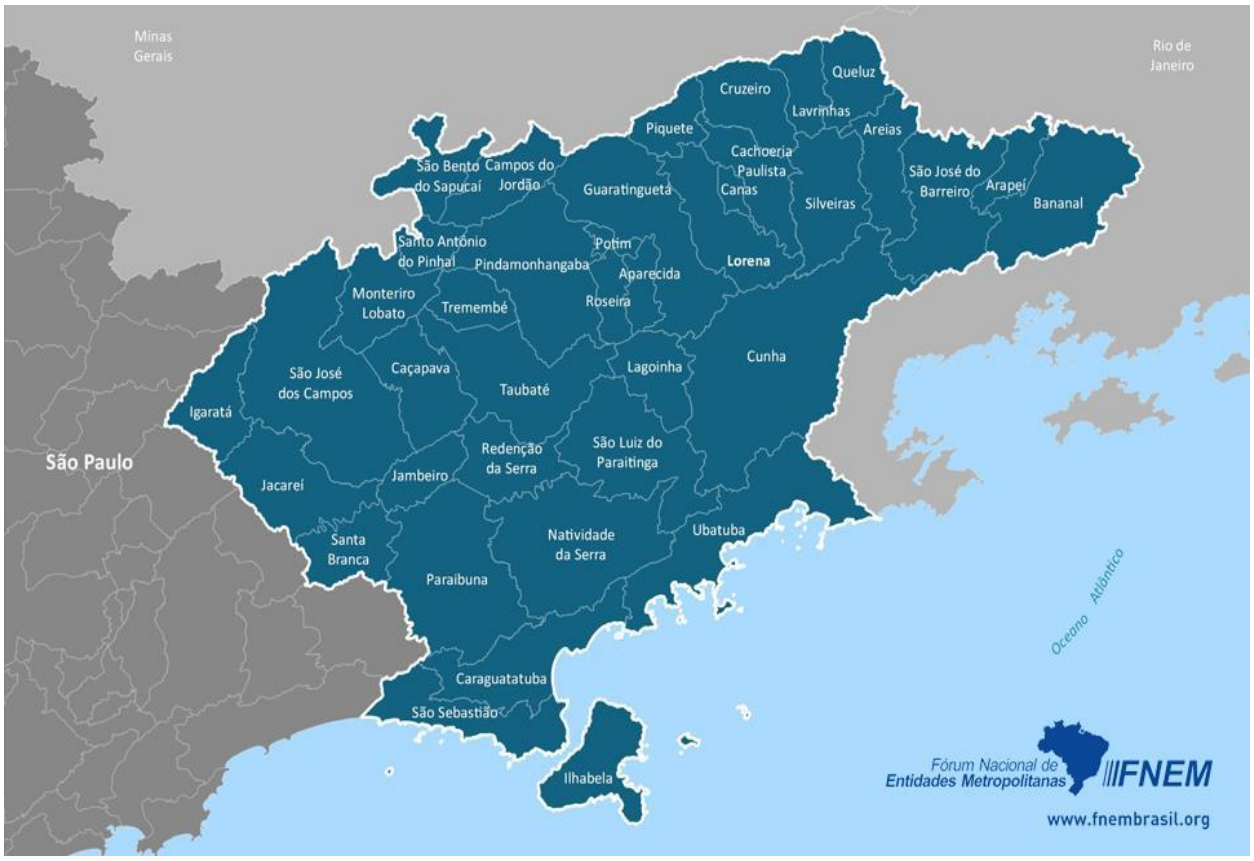

Fig.3: Metropolitan Region of the Paraíba River Valley and North Coast
Source: FNEM, 2019

The municipality of São José dos Campos concentrates 5.8% of the exports of the entire State of São Paulo, being the fifth largest exporter in the state and the twelfth largest exporter in the country (MDIC, 2018). Its GDP represents 1.83% of state GDP (SEADE, 2018).

Headquarters of the largest aerospace hub in Latin America, São José dos Campos brings together high technology companies and important research and teaching centers. The city is the only one to have in its Technology Park the three largest aircraft manufacturers in the world: Embraer (Brazilian Aircraft Company), Boeing and Airbus. The main companies are: General Motors (automotive), Petrobras (oil and gas), Ericsson (telecommunications), Johnson & Johnson (pharmaceutical) and Panasonic (electronics) (PREFEITURA, 2018).

Institutions of teaching and research are also present in São José dos Campos, such as the ITA (Technological Institute of Aeronautics), UNIFESP (Federal University of São Paulo), UNESP (Paulista State University), UNIVAP (University of Paraíba Valley) and FATEC (Faculty of Technology of the State of São Paulo) (PREFEITURA, 2018).

The city has the Technological Park of São José dos Campos, which houses three business incubators, four business centers, two Local Productive Arrangements (LPA), four technological development centers, three multi-user laboratories, a business office, six partner universities and three entrepreneurial galleries. Altogether there are more than 300 companies linked to the organization (PARQUE TECNOLÓGICO, 2018).

The Local Productive Arrangement of Information Technology and Communication (LPA TIC Vale) was

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

created in 2011 and today brings together 67 companies that work in the development of hardware, software and IT services, focusing on retail, smart cities and industry 4.0. The Brazilian Aeroespace Cluster, with a Local Productive Arrangement (LPA) format, was formed in 2009 and brings together 94 companies from the aerospace and defense chains. Its anchor company is Embraer. In all, there are 23 thousand jobs and annual turnover of € 5,920,950 (TECNOLOGICAL PARK, 2018).

The city council of the city of São José dos Campos has invested in technology to improve the life of the residents. The concept of 'Smart Cities' is present in the municipality in areas such as health, education, urban planning, public safety, sport and culture. Among the actions are Internet medicine consultation, incentive to entrepreneurship in municipal schools, IOC (Integrated Operations Center), use of LED technology lamps in public roads, electric Municipal Guard vehicles, among others (PREFEITURA, 2018).

The municipality also has an innovation law, law 9563/2017 wich establishes a legal framework what it was established the "Incentive Program for Scientific, Technological and Sustainable Innovation of São José dos Campos" aiming at receiving innovative projects for evaluation provided they can improve public works and services for the benefit of the population (PREFEITURA, 2018).

In addition, the municipality has the " São José in the Palm of the Hand ", a set of ten free applications for smartphones and tablets in the areas of health, urban mobility, sports, public safety and maintenance of the city, whose objective is to provide transparency and ease to citizens. Figure 4 shows the logos of the mobile apps of "São José in the Palm of the Hand" (PREFEITURA, 2018).

Fig.4: Mobile apps of "São José in the Palm of the Hand"
Source: Prefeitura, 2018.

São José dos Campos is among the Brazilian cities considered to be smart, according to the Connected Smart Cities Ranking. Table 8 shows the evolution of the city in the general ranking composed of one hundred municipalities. It is observed that the city fell from 12th place in 2015 to 34th place in the ranking in 2018. Despite the fall of positions, the city's score remained within an average of 26 points. For comparison purposes, the city of Curitiba (PR), which ranks first in the ranking, obtained 31,782 points. The city of Maceió (AL), ranked in the ranking as the hundredth most intelligent city in the country, obtained 24,083 points.

Table 8. Evolution of São José dos Campos in the Connected Smart Cities ranking.

	2015	2016	2017	2018
Position	12ª	24ª	37ª	34ª
Score	25,150	29,094	25,669	26,147

Source: prepared by the authors.

Table 9 shows the evolution of the city in the Connected Smart Cities ranking by sector analyzed. The sectoral ranking analyzes the fifty best cities in the respective sector. It is noticed that the city was never among the fifty best placed in the sectors of Environment, Energy, Health, Safety and Governance. The city presented better performance in the sectors of Urbanism, Technology and Innovation and Entrepreneurship. It is important to note that, in the year 2018, in the Entrepreneurship sector, the municipality was not ranked among the top fifty positions. This is surprising given that the city is nationally recognized as an entrepreneurial one. The city was the tenth place in the ranking "Entrepreneurial Cities Index" prepared by Endeavor Brasil in 2017 (ENDEAVOR, 2018). Already in the period between 2015 to 2017, the city was among the fifty first evaluated. There is a fall on performance in the sectors analyzed, with the exception of the Mobility and Accessibility sector in which it was first classified in 2018.

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table 9. Evolution by sector in the Connected Smart Cities ranking of São José dos Campos.

	2015		2016		2017		2018	
Sector	Position	Score	Position	Score	Position	Score	Position	Score
Mobility and Accessibility	-	-	-	-	-	-	38ª	3,125
Urbanism	3ª	7,68	8ª	7,619	-	-	44ª	5,451
Environment	-	-	-	-	-	-	-	-
Energy	-	-	-	-	-	-	-	-
Technology and inovation	-	-	16ª	3,585	14ª	3,875	19ª	3,813
Education	-	-	35ª	3,791	38ª	4,131	-	-
Health	-	-	-	-	-	-	-	-
Safety	-	-	-	-	-	-	-	-
Entrepreneurship	7ª	2,140	14ª	2,592	46ª	2,390	-	-
Economy	-	-	-	-	29ª	5,079	-	-
Governance	-	-	-	-	-	-	-	-

Source: prepared by the authors.

Another fact to be observed is that cities with less than 100 thousand inhabitants, such as Viçosa (MG) (26 th position) and Vinhedo (SP) (32 th position), are considered by the ranking to be more intelligent than São José dos Campos and other cities of greater bearing. According to Giffinger and Gudrun (2010), questions regarding the criteria for city selection as well as the aggregation procedure should be treated from a methodological point of view: to make the classification approach more transparent, the definition of the sample of cities is essential. For the European Smart Cities ranking (2007) the cities must be of medium size, that is, urban population between 100 thousand and 500 thousand. As for the Connected Smart Cities ranking, cities with a minimum of 50 thousand inhabitants are considered in the final list. This allows situations such as that of the two municipalities mentioned to occur.

Giffinger and Gudrun (2010) emphasize that many funders seek clear results, which can be easily communicated in public, and therefore, most classifications aim to find the city better or more attractive. Placing in the final list cities with different sizes may cause misinterpretations because, according to Giffinger et al. (2007), the focus of the public is mainly on the final ranking.

The authors of this study point out, in view of the considerations regarding the observed values, that process of drawing up rankings of cities should be improvement whit the object to reduce random variations and provide more consistency to the results.

It is important to note that the Connected Smart Cities ranking has undergone changes in the list of indicators, increase in the number of cities and methodology for calculating some indicators since the first edition.

But it is not possible to discuss in more depth the causes of this performance, since, as Giffinger et al. (2007) say the general city list is made available for free, but deeper insights and results are often not available, as is the Connected Smart Cities ranking. This finding may be related with the fact that the ranking is type 2 in the classification proposed by Giffinger and Gudrun (2010).

The authors suggest that future studies should be carried out to verify and analyze in more depth the results of the municipality indicators, since with the data provided by the Connected Smart Cities ranking it is not possible to reach a conclusion on the causes of the fall in performance in the general ranking and in the sectors of a city as of São José dos Campos.

5.2 Toulouse

The city of Toulouse is the fourth largest city in France after Paris, Marseille and Lyon, with 471,941 inhabitants (INSEE, 2018). Toulouse Métropole is a public institution of inter-municipal cooperation (EPCI - Établissement Public de Coopération Intercommunale) created in January 2015. In 1992, the first intercommunal entity called the District of Greater Toulouse was created with 13 municipalities. Now it brings together 37 municipalities that join forces in an area of solidarity to develop and lead together a common space planning project. The metropolitan region, as shown in Figure 5, has 746,919 inhabitants (TOULOUSE MÉTROPOLE, 2018).

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

Fig.5: City of Toulouse in the metropolitan area.
Source: https://www.toulouse-metropole.fr

According to Lucena and Vicente (2017), the Greater Toulouse is a leading and historic place for the aeronautics and space industries in Europe. The main companies of these two industries and some of their factories are located in Toulouse, for example: Airbus, Airbus Defense and Space, ATR Aircraft, Thales Alenia Space, Safran, among others. The city houses the main schools of engineering and research in this technological field: Sup'Aero, ONERA, Federal University of Toulouse, among others. The city is home to the National Center for Space Studies (CNES). This cluster has three main characteristics: (i) its maturity, since it leads the European aeronautical and space industries, (ii) its centrality, since it is at the center of all European industrial and innovation networks in the technologicalfield; (iii) its diversification in development, as it faces challenges related to environmental constraints and new balances between military and civil market opportunities, in particular in the cross-sectoraldomain of embedded systems, leading to the emergence of new industries such as GNSS (Global Navigation Satellite Systems), drones and other related industries.

The city has the Smart City 2015-2020 project, which aims to build tomorrow's smart city with citizens: more fluid, friendly, innovative, dynamic, attractive, responsible and sustainable. The Smart City Master Plan was adopted in December 2015 and has up to 500 million euros of public investment by 2020 to transform Toulouse into "Open Metropolis". The metropolis also has private companies in this project. The leverage effect in terms of private investment is estimated at € 200 million (TOULOUSE MÉTROPOLE, 2018).

A master plan and a strategy based on three principles and five ambitions were defined in 2015:

- Principles:

1. The citizen placed at the center of the proceedings;
2. Shared public data as a basis for Smart City;
3. A public-private co-construction.

- Ambições:

1. A metropolis open to an adaptable, efficient and breathable city.
2. A metropolis open for simpler and more fluid mobility.
3. An international metropolis open and concerned with its roots.
4. A metropolis open to an even more warm and intergenerational city of well-being.
5. A metropolis opened to make Toulouse more beautiful, clean and safe.

Project Results:

- More than 350 associated citizens;
- 80 companies, clusters and groups mobilized;
- 30 companies involved in projects;
- Public investment target of € 500 million by 2020 (excluding large mobility projects);
- 2 international awards of "Smart City" (Smart Mobility City Award - Hong Kong; Access City Award - Brussels);
- 10 startup experiences;
- 15 iconic projects.

5.3 Comparison of indicators of the two cities

Seven European Smart Cities indicators were selected to compare the two cities. The choice of indicators was for convenience and ease of data collection. Chart 10 shows the values of the respective indicators.

Table 10. Comparison of Smart Economy indicators for cities.

	São José dos Campos	Toulouse
Economically active population	217,903 people	316,357 people
GDP per capita (€)	10,169.16	7,083.77
Number of patent applications	50	255
Unemployment rate (%)	13.70	9.40
Number of enrollments in day care	18,056	14,588
Number of private cars registered	300,781	306,847
Cycle paths (meters)	96,180	314,000

Source: prepared by the authors.

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

For the indicator "economically active population", the São José dos Campos data comes from the IBGE Cities platform for the year 2016 (IBGE, 2018). The Eurostat Toulouse data for the year 2015 (EUROSTAT, 2018).

In the "GDP per capita" indicator, data referring to the year 2015 were used. The São José dos Campos data comes from the Seade Foundation (SEADE, 2018). Toulouse data from Eurostat (EUROSTAT, 2018). The data refer to the metropolitan regions of São José dos Campos and Toulouse. To analyze the result in a holistic way, it is necessary consider the distribution of wealth produced in the region. For this, it may be used the Gini index, an indicator used to measure the degree of concentration of income. The indicator varies from 0 to 1, with zero representing the situation of total equality, that is, all have the same income, and the value 1 means complete income inequality, that is, if a single person owns all the income of the place . Although the city of São José dos Campos presents a GDP per capita higher than that of the city of Toulouse, the value of its Gini index is 0.550 (ATLAS BRASIL, 2019). The Gini index in Toulouse is 0,327 (THE WORLD BANK, 2019). São José dos Campos has a higher income concentration than that of the city of Toulouse. Despite having a smaller income, Toulouse distributes its income better, which should explain the apparent unexpected difference observed.

For the indicator "number of patent applications" there were difficulties in finding values. For the city of São José dos Campos, the average number of patents deposited in the period from 2014 to 2017 was used due to the availability of data only in this period. The São José dos Campos data comes from INPI - National Institute of Industrial Property (INPI, 2018). For the city of Toulouse the average number of patents deposited in the period from 2008 to 2012 was used due to the availability of data only in this period. The Toulouse data comes from Eurostat (EUROSTAT, 2018). Caragliu and Bo (2018) verified in their study that Smart Cities policies really stimulate innovation, which increases the stock of knowledge of a city, one of the main recognized drivers of economic growth. According to the authors, the propensity to innovate is measured by the number of patents registered in: total patent applications, high-tech patent applications, applications for Information and Communication Technology (ICT) and Smart City patent applications. The average number of patents registered in the period for the city of Toulouse is much higher than that of São José dos Campos, which may indicate that the adoption of policies that stimulate innovation and Smart Cities contributes to this result. The city of Toulouse has a specific master plan for Smart City, with clear goals until the year 2020. The city of São José dos Campos, despite having an innovation law, has not yet a plan dedicated to the Smart City theme.

In the "unemployment rate" indicator, there were difficulties in finding values referring to the municipalities. For both cities, the national unemployment rate was considered. The São José dos Campos data comes from IBGE and the data from Toulouse come from Eurostat (IBGE, 2018, EUROSTAT, 2018).

The data of São José dos Campos are from the "Synopses Statistics of Basic Education" of the National Institute of Educational Studies and Research Anísio Teixeira (Inep) for the year 2018 (INEP, 2018). The data for Toulouse refer to the year 2017 and come from Eurostat (EUROSTAT, 2018).

The indicator "number of private cars registered" of São José dos Campos refers to the year 2018 and come from the National Department of Transit - Denatran (DENATRAN, 2018). For Toulouse data, the average for the years 2009 to 2015 was taken from Eurostat data (EUROSTAT, 2018).

The indicator "cycle paths" of the city of São José dos Campos refers to the year 2018 and comes from the Department of Urban Mobility of the municipality (PREFEITURA, 2018). For the data of Toulouse was considered the data of the metropolitan authority with current data (TOULOUSE MÉTROPOLE, 2018).It can be seen that the city of Toulouse has more than three times the number of bicycle lanes implanted than São José dos Campos. This result reflects the focus given in the past to other transport modes in the city of São José dos Campos, a common feature in Brazilian cities. Currently, the city has an Urban Mobility Plan and a program to encourage the use of the bicycle, which includes the extension and connection of the bicycle lane, shared bicycles, conscious use of the modal and legislation. The goal is that by 2020 the city will reach 157,000 meters of the cycle network.

The observations made allow us to conclude that the city of Toulouse has an advantage over São José dos Campos in terms of economically active population, number of patent applications, unemployment rate and bicycle lanes, which may be considered acceptable due to having a city longer established in an important regional industrial center, besides being in an arguably more developed country.

In the other items examined, that is, GDP per capita, number of day care registrations, number of private cars registered, there was no clear differentiation in favor of any of the municipalities.

https://dx.doi.org/10.22161/ijaers.68.13 ISSN: 2349-6495(P) | 2456-1908(O)

The example examined suggests that it is possible, to establish a competitive differential between cities, selecting exactly the same qualifying characteristics.

VI. CONCLUSION

The concept of "smart city" has become popular in scientific literature. The article provided information that corroborates this increased interest of the researchers on the subject. The population living in the cities has increased in the last decades and has a tendency of growth in the next years. As a result of this increase, new urban challenges have emerged, establishing a new paradigm for city management. To measure these new challenges and to assist municipal governance, various city rankings initiatives are emerging and assisting managers in this regard.

The comparative analysis of the European Smart Cities and Connected Smart Cities rankings made it possible to verify that both have convergences in most of their indicators. For the elaboration of the Brazilian ranking, international rankings already established were consulted, which may explain this convergence.

It can be seen that the European ranking has more academic characteristics and provides a more in-depth analysis of the cities data. In its web page is present a tool of comparison between the cities and a general ranking. The ranking encourages benchmarking between selected cities.

Another characteristic that differentiates the European ranking of the Brazilian one is the number of cities analyzed. While the Brazilian ranking analyzes more than 500 cities, the European ranking establishes more strict criteria of selection, establishing a number of only 70 cities wich were analyzed. In the Brazilian ranking, only the 100 best cities in each intelligence sector of the city are listed in the final ranking.

It is noticed that the choice of indicators for both rankings reflects the current situation of each analysed region with regard to its development. While the European ranking has indicators such as "book loans per resident", the Brazilian ranking still establishes as a criterion of intelligence of a city the indicator "teachers with higher education". This portrays the concerns of both rankings with respect to the analysis of education in an intelligent city, but at distinct levels of development. This disparity in the choice of ranking indicators portrays issues of economic and social development in both regions and reinforces the challenge of comparing cities around the world.

In the comparison between the cities of São José dos Campos and Toulouse, it can be concluded that both have similar regional characteristics due to the regional technological development. Both have a structured network of companies and educational institutions linked to the aerospace chain, motivated in the past by private and governmental initiatives.

Toulouse has a specific master plan for smart cities. This master plan sets goals and criteria within a five-year period for transforming Toulouse into a smart city. The existence of a master plan for Smart City in Toulouse justifies the results obtained by the city and awards in this area. Already, São José dos Campos has only isolated initiatives of Smart City, needing to evolve towards the adoption of public policies aiming at this condition and considering its predominant vocations.

Regarding the performance of each city in the rankings of smart cities, the analysis showed that São José dos Campos moved from the 12th place in 2015 to the 34th place in 2018 in the country ranking.

For the city of Toulouse it was not possible to verify the position of the city in relation to the others in the ranking. The European ranking has not a general structured classification for cities with more than 500 thousand inhabitants. It is noticed through the Toulouse scores that the city performs well in the smart city sectors.

The nature of the city rankings is comparative. As such, the city must go beyond analyzing its own performance and expanding its analysis to include similar cities. For example, São Jose dos Campos can compare with the best performers, but should also look at cities of comparable size, GDP, geography, maturity and aspirations for global status - a group that could include a wide range of cities. Therefore it is not trivial to perform a comparison.

The present study shows the extent to which it a comparison can be done between two cities considered at regional and global technological poles in the aerospace area. Of course in conducting a detailed analysis of cities within a peer group, city managers can have a sense of where they need to improve and the impact of progress. In addition, they can set strategic goals for attracting investments and talents in their characteristic economic area of the city.

With the present work, the authors expect to have shown it is concluded that the city rankings are necessary tools for managers to elaborate public policies to make a city smarter. However, the visualization of an index is not always enough to observe all the characteristic aspects of intelligent cities, and may not show some revealing points. When the main purpose is to create headlines or attract potential customers, rankings can distort a clear and constructive discourse on how cities can improve. Instead, by refining approaches, improving data collection and analysis, and promoting methodological transparency, organizations that produce city performance literature can

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

create an indispensable tool for developing more effective urban strategies and promoting knowledge sharing and collaboration between global cities.

Cultural differences are present in the comparative of the rankings, which allows establishing paths of evolution for the Brazilian ranking. The authors suggest further studies in the two cities to understand some results found. In addition, it is suggested as future studies to verify if the existence of structured policies of intelligent cities contribute in specialized supply chains such as the analyzed aerospace chain. The authors conclude that, in view of the observed value considerations, the process of elaborating city rankings should be refined in order to reduce random variations and give more consistency to the results.

REFERENCES

[1] ALBINO, V.; BERARDI, U.; DANGELICO, R. M. Smart Cities : Definitions , Dimensions , Performance , and Initiatives. n. February, p. 37–41, 2015.

[2] Amoêda, R. (2013). Cidades Digitais: Novas Modos de Habitar? Workshop Cidades e regiões Digitais, Impacto na Cidade e nas Pessoas. Universidade Fernando Pessoa, Porto.

[3] Atlas do Desenvolvimento Humano no Brasil. 2018. Disponível em: http://www.atlasbrasil.org.br/2013/pt/perfil_rm/90 acessado em 24 de fevereiro de 2019.

[4] BERARDI, Umberto. Clarifying the new interpretations of the concept of sustainable building. Sustainable Cities and Society, v. 8, p. 72-78, 2013.

[5] BERARDI, Umberto. Sustainability assessment of urban communities through rating systems. Environment, development and sustainability, v. 15, n. 6, p. 1573-1591, 2013.

[6] Bosch, P., S. Jongeneel, V. Rovers, H. Neumann, M. Airaksinen, and A. Huovila. 2017 "CITYkeys Indicators

[7] for Smart City Projects and Smart Cities." 305. Accessed January 24, 2017. http://nws.eurocities.eu/

[8] MediaShell/media/CITYkeysD14Indicatorsforsmartcityprojectsandsmartcities.pdf

[9] Buhrkal, K., Larsen, A. e Ropke, S. (2012). The waste collection vehicle routing problem with time windows in a city logistics context. Procedia-Social and Behavioral Sciences 39, 241– 254, https://doi.org/10.1016/j.sbspro.2012.03.105.

[10] CARAGLIU, Andrea; BO, Chiara F. del. Smart innovative cities: The impact of Smart City policies on urban innovation. Technological Forecasting And Social Change, [s.l.], p.1-11, jul. 2018. Elsevier BV. http://dx.doi.org/10.1016/j.techfore.2018.07.022.

[11] CARLI, Raffaele et al. Measuring and managing the smartness of cities: A framework for classifying performance indicators. In: Systems, Man, and Cybernetics (SMC), 2013 IEEE International Conference on. IEEE, 2013. p. 1288-1293.

[12] CHOURABI, Hafedh et al. Understanding smart cities: An integrative framework. In: System Science (HICSS), 2012 45th Hawaii International Conference on. IEEE, 2012. p. 2289-2297.

[13] Connected Smart Cities. (2018). Disponível em: <http://ranking.connectedsmartcities.com.br/ > Acesso em: 01 de out. de 2018.

[14] DE HALLEUX, Morgane et al. How "smart" are Latin American cities?. ECARES Working Papers, v. 2018, 2018.

[15] Endeavor. (2018). Disponível em: < http://info.endeavor.org.br/ice2017> Acesso em: 01 de out. de 2018.

[16] SOUZA, Adriane Aparecida Moreira de; COSTA, Wanderley Messias da. Análise de uma Tecnópole Brasileira: O caso do Complexo tecnológico-industrial-aeroespacial de São José dos Campos. Geografia: Revista da Faculdade de Letras da Universidade do Porto, n. 1, 2012.

[17] DÜHR, Stefanie. Potentials for polycentric development in Europe: The ESPON 1.1. 1 project report. Planning, Practice & Research, v. 20, n. 2, p. 235-239, 2005.

[18] EMPLASA, Empresa Paulista de Planejamento Metropolitano SA. 2018. Disponível em https://www.emplasa.sp.gov.br/RMVPLN acessado em 06 de março de 2018.

[19] FNEM, Fórum Nacional de Entidades Metropolitanas. 2019. Disponível em http://fnembrasil.org/regiao-metropolitana-do-vale-do-paraiba-e-litoral-norte-sp/ acessado em 23 de fevereiro de 2019.

[20] Fernandes, R. J. L., & Fernandes, R. J. G. (2006). A cidade digital vs a cidade inteligente: estratégias de desenvolvimento sócio-económico e/ou de marketing territorial.

[21] GASPAR, Jadhi Vincki ; AZEVEDO, Ingrid Santos Cirio de ; TEIXEIRA, Clarissa Stefani . Analysis ranking Connected Smart Cities. In: Congresso Internacional de Conocimento e Innovación, 2016, Bogotá. CIKI 2016, 2016.

[22] GIFFINGER, Rudolf et al. City-ranking of European medium-sized cities. Cent. Reg. Sci. Vienna UT, p. 1-12, 2007.

[23] GIFFINGER, Rudolf; GUDRUN, Haindlmaier. Smart cities ranking: an effective instrument for the positioning of the cities?. ACE: Architecture, City and Environment, v. 4, n. 12, p. 7-26, 2010.

[24] INPI — Instituto Nacional da Propriedade Industrial, http://www.inpi.gov.br/sobre/estatisticas/estatisticas-preliminares-2013-a-partir-de-2013

[25] Instituto Brasileiro de Geografia e Estatística (IBGE), https://cidades.ibge.gov.br.

[26] Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP), http://inep.gov.br/sinopses-estatisticas-da-educacao-basica.

[27] Insee - Institut national de la statistique et des études économiques. 2018. Disponível emhttps://www.insee.fr/fr/accueil

https://dx.doi.org/10.22161/ijaers.68.13 *ISSN: 2349-6495(P) | 2456-1908(O)*

[28] N. Komninos, Intelligent Cities: Innovation, Knowledge Systems and Digital Spaces(London: Spon Press, 2002).
[29] LAZAROIU, George Cristian; ROSCIA, Mariacristina. Definition methodology for the smart cities model. Energy, v. 47, n. 1, p. 326-332, 2012.
[30] Lemos, A. (2013). Cidades inteligentes. GVexecutivo, v. 12, n. 2, p. 46-49.
[31] LEYDESDORFF, Loet; DEAKIN, Mark. The triple-helix model of smart cities: A neo-evolutionary perspective. Journal of urban technology, v. 18, n. 2, p. 53-63, 2011.
[32] LOMBARDI, Patrizia et al. Modelling the smart city performance. Innovation: The European Journal of Social Science Research, v. 25, n. 2, p. 137-149, 2012.
[33] LUCENA PIQUERO, Delio; VICENTE, Jerome. The visible hand of cluster policy makers: An analysis of Aerospace Valley (2006-2015) using a place-based network methodology. 2017.
[34] MCCARNEY, Patricia. The evolution of global city indicators and ISO37120: The first international standard on city indicators. Statistical Journal of the IAOS, v. 31, n. 1, p. 103-110, 2015.
[35] MDIC, Ministério da Indústria, Comércio Exterior e Serviços. 2018. Disponível em http://www.mdic.gov.br/comercio-exterior/estatisticas-de-comercio-exterior/comex-vis/frame-municipio?municipio=3449904acessado em 10 de novembro de 2018.
[36] Parque Tecnológico - São José dos Campos, http://www.pqtec.org.br
[37] Prefeitura Municipal de São José dos Campos, http://www.sjc.sp.gov.br
[38] RBCIH (2016). Brasil 2030: cidades inteligentes e humanas. Disponível em: http://redebrasileira.org/brasil-2030.
[39] Seade - Fundação Sistema Estadual de Análise de Dados, http://www.seade.gov.br
[40] Toulouse Métropole - instituição pública de cooperação intermunicipal (EPCI), https://www.toulouse-metropole.fr
[41] United Nations - Population Division of the Department of Economic and Social Affairs, https://population.un.org/wup/. Accessed in January (2019).
[42] ZYGIARIS, Sotiris. Smart city reference model: Assisting planners to conceptualize the building of smart city innovation ecosystems. Journal of the Knowledge Economy, v. 4, n. 2, p. 217-231, 2013.
[43] WWCD (2017). World Council on City Open Data Portal. Disponível em: http://open.dataforcities.org/
[44] THE WORLD BANK (2019). World Development Indicators. Disponível em: https://datacatalog.worldbank.org/dataset/world-development-indicators