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Smart City: a diagnosis of the economic aspects and productive force of the Federal District

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Abstract

Objective: To diagnose the economic aspects and the productive force of the Administrative Regions of the Federal District, in the light of the characteristics that make up the concept of smart cities.
Methodology: Secondary data on the economy were extracted from the Federal District government website referring to information on the planning of government activities, the Pluriannual Plan, and Budget Balance, period 2016-2019. As for the productive force, the information was obtained from the Federal Revenue website, called Cnpj.info, from more than 263 thousand business entities, in 2018. Based on content analysis techniques and spatial analysis, the organizational entities were grouped into five categories of technological intensity, classified by the Organization for Economic Cooperation and Development (OECD) as high, medium-high, medium, medium-low, and low technological intensity.
Originality/Relevance: The study is justified considering information on the development characteristics of the regions contributes to the improvement of public policies in the construction of modern cities, in addition to identifying flaws and opportunities, reproducing good examples for the understanding research on this current matter.
Results: The mapping made it possible to know the types of companies and their potential, as well as the economic and innovative competences in the Federal District. In 2018, there were 112 business entities classified as having a high level of technology intensity. Micro-enterprises concentrated most companies at all technological levels, totaling 178,289. The Federal District still has an incipient productive force regarding the process of building a smart city.
Social contributions / for management: It is intended to contribute to decision-making in the field of public policies aimed at economic and social actions in the Federal District, especially with a view to the field of production and innovation that enable the structuring of a smart city in line with the new global development.

Keywords: Smart City. Federal District. Innovation. Urban Management.

Cidade Inteligente: diagnóstico dos aspectos econômicos e da força produtiva do Distrito Federal

Resumo

Objetivo: O objetivo do trabalho foi diagnosticar os aspectos econômicos e da força produtiva das Regiões Administrativas do Distrito Federal, sob a luz das características que compõem o conceito de cidades inteligentes.
Metodologia: Dados secundários da economia, foram extraídos do sítio governamental do Distrito Federal referente às informações do planejamento de atividades do governo, o Plano Plurianual, e

Balanço Orçamentário, período de 2016-2019. Enquanto da força produtiva, as informações foram obtidas do sítio da Receita Federal, denominado Cnpj.info, de mais de 263 mil entidades empresariais, ano de 2018. A partir de técnicas de análise de conteúdo e de uma análise espacial, as entidades foram agrupadas em cinco categorias de intensidade tecnológica, classificadas pela Organização para Cooperação e Desenvolvimento Econômico (OCDE) em alta, médio-alta, média, médio-baixa e baixa intensidade tecnológica.
Originalidade/Relevância: As informações sobre características de desenvolvimento das regiões contribuem para o aprimoramento de políticas públicas na construção de cidades modernas, além de identificar falhas e oportunidades, reproduzindo bons exemplos para a compreensão e programa de pesquisas sobre essa atual matéria.
Resultados: O mapeamento permitiu conhecer os tipos de empresas e suas potencialidades, bem como, as competências econômicas e inovadoras no Distrito Federal. Em 2018, havia 112 entidades empresariais classificadas com alto nível de intensidade tecnológica. As microempresas concentravam a maior parte de empresas em todos os níveis tecnológicos, perfazendo um total de 178.289. O Distrito Federal ainda apresenta uma força produtiva incipiente no que tange ao processo de construção de uma cidade inteligente.
Contribuições sociais / para a gestão: Pretende-se contribuir com a tomada de decisão no campo de políticas públicas que vise ações econômicas e sociais no Distrito Federal, especialmente com a visão do campo de produção e inovação que viabilizem a estruturação de uma cidade inteligente alinhando-se às novas perspectivas globais de desenvolvimento.

Palavras-chave: Cidades Inteligentes. Distrito Federal. Inovação. Gestão Urbana.

Smart City: Diagnóstico de los aspectos económicos y fuerza productiva del Distrito Federal

Resumen
Objetivo: Diagnosticar los aspectos económicos y la fuerza productiva de las Regiones Administrativas del Distrito Federal, a la luz de las características que conforman el concepto de ciudades inteligentes.
Metodología: Los datos secundarios de la economía fueron extraídos de la página web del gobierno del Distrito Federal con respecto a la información sobre la planificación de actividades gubernamentales, el Plan Plurianual y el Balance Presupuestario, período 2016-2019. En cuanto a la fuerza productiva, la información se obtuvo del sitio web de Ingresos Federales, denominado Cnpj.info, de más de 263 mil entidades empresariales, en 2018. Con base en técnicas de análisis de contenido y análisis espacial, las entidades fueron agrupadas en cinco categorías de intensidad tecnológica, clasificada por la Organización para la Cooperación y el Desarrollo Económicos (OCDE) en intensidad tecnológica alta, media-alta, media, media-baja y baja.
Originalidad / Relevancia: La información sobre las características de desarrollo de las regiones contribuye al perfeccionamiento de las políticas públicas en la construcción de ciudades modernas, además de identificar brechas y oportunidades, reproduciendo buenos ejemplos para el programa de comprensión e investigación sobre esta materia actual.
Resultados: El mapeo permitió conocer los tipos de empresas y su potencial, así como las competencias económicas e innovadoras en el Distrito Federal. En 2018, había 112 entidades comerciales clasificadas como de alto nivel de intensidad tecnológica. Las microempresas concentran la mayoría de las empresas en todos los niveles tecnológicos, totalizando 178.289. El Distrito Federal aún cuenta con una fuerza productiva incipiente en cuanto al proceso de construcción de una ciudad inteligente.
Contribuciones sociales a la gestión: Se pretende contribuir a la toma de decisiones en el campo de las políticas públicas dirigidas a la acción económica y social en el Distrito Federal, especialmente con miras al campo de la producción y la innovación que permitan la estructuración de una ciudad inteligente en consonancia con las nuevas perspectivas globales de desarrollo.

Palabras-clave: Ciudades inteligentes. Distrito Federal. Innovación. Gestión Urbana.

Introduction

According to the United Nations (UN), by 2050 cities will be home to 70% of the world's population. From this perspective, there is a need for a debate that proposes mechanisms to

contain unbridled population growth and unstructured urbanization. In this context, there are suggestions based on the implementation of new technologies that can minimize technical, social and economic problems, in addition to enabling effective planning for economic, organizational and environmental sustainability (Lazzaretti, Sehnem, Bencke, & Machado, 2019).

Neirotti et al. (2014) said that the movement of attention to urban development brought along the concept of smart and sustainable socioeconomic growth. As a result, there is a proposal for smart cities that seek to optimize the use of resources and infrastructure in a sustainable way to improve the population's quality of life. In this context, cities seek a holistic view of the various actors involved, namely: people, infrastructure, and technology. The latter is used as a great ally in building the intelligence of the city. In the meantime, the interaction between the social, economic, and environmental dimensions takes place, and it is capable of promoting social and innovative transformation for the city (Monfaredzadeh & Krueger, 2015; Beck et al. 2020).

For Weiss (2017), in Brazil it is also possible to observe the phenomenon of intense urbanization and that the coming decades will present changes in the spaces occupied in the country. Nevertheless, government leaders have created agendas to face these future challenges. As an example, the Statute of Cities, Federal *Law nº. 10,257 (2001)* is cited, which establishes in its lines the regulation of urban policy and environmental balance. Among its guidelines, the statute ensures the exercise of the right to sustainable cities that include dignified living conditions, full exercise of citizenship and human rights, participation in city management and quality of life from the social and environmental aspects (*Law nº 10.257, 2001*).

Faced with these changes, the government seeks to foresee policies that favor agility, efficiency, and transparency in the construction of smart cities (Weiss, Bernardes, & Consoni, 2017). In this context, innovation assumes a fundamental role in the construction and fulfillment of demands. By creating innovation laboratories, it is possible to promote the search for creative solutions for the use of technology to solve the city's problems.

In this regard, Harrison and Donelly (2011) present the concept of smart cities, related to the implementation of technologies in complex information systems for a new urban planning. Corroborating this understanding, Batty et al. (2012) emphasize that the definition of intelligence for cities is based on the efficiency of local development through innovation, novelties, or economic prosperity. This is considered one of the paradigms on which theoretical studies are based for the concept of smart city: cities have complex systems (Batty, 2008).

However, the concept of smart cities still lacks a consensus in the literature (Hollands, 2008; Batty et al., 2012; Weiss, Bernardes, & Consoni, 2015; Kon & Santana, 2016). Therefore, it is common that the evaluation or the way in which cities become smart is related

to a set of aspects. Neirotti et al. (2014) classify it as the domain of application through which policymakers and city managers articulate the proposition of smart city initiatives. For Beck and Conti (2021), the concept of smart cities is not presented as the gap in the literature, but as the reasons, factors or variables that can explain why such cities become smarter.

Because of strategic initiatives, economic, social, and environmental standards are converging at levels of competition between cities. Given this competitiveness, the comparison of initiatives has driven the use of rankings that can measure the positioning of cities in terms of the degree of development and applied initiative (Giffinger & Gudrun, 2010).

Giffinger and Gudrun (2010) presented a framework with six analyzable dimensions to classify the smartest European cities: (i) an economy that promotes city intelligence by creating improvements in the business environment with adequate legislation and business infrastructure; (ii) governance that includes ease of use of public services, investments in technology and transparency in data and in the use of city resources; (iii) mobility, which includes the efficiency of the different modes of transportation; (iv) an environment that makes the interface between the intelligent use of natural resources such as water and energy with sustainability; (v) people, a dimension in which human capital and social context are analyzed; (vi) life, which concerns the promotion of an intelligent quality of life.

In the meantime, the Federal District Government exposed its Strategic Plan (2019-2060) which brings together initiatives, goals, and actions for the federal capital until its centenary, in addition to the commitment to consolidate the concept of smart cities as a strategic instrument for the planning and management of its territory (Government of the Federal District [GDF], 2019).

The present study aims to diagnose the current state of the economic aspects and the productive force of the administrative regions of the Federal District. When mapping the economic behavior of localities, we seek to investigate the domains that provide structures in the light of economic functions: industry, energy, transportation, and education. On the other hand, diagnosing the productive force of the Federal District allows for the identification of the levels of production capacity existing in the regions, namely: high, medium-high, medium, medium-low and low technological intensity. In this way, the present work aims, from an exploratory study, to analyze the reasons that can influence the construction of a smart city.

The article is composed of five sections, the first being this introduction. The second section is dedicated to information from the literature regarding the concept of smart cities and innovation policy perspectives. The third section presents the methodological procedures addressed in the research. The fourth section presents the discussions of the results. Finally, the fifth and last section is dedicated to the final considerations of the presented study.

Literature Review

Smart Cities

The dynamics of population urbanization in the 21st century has brought a new reality: most of the world population is living in urban cities (Ribeiro, 2020). In this regard, there is also a new global concern that is to adjust existing infrastructure and resources in cities to accommodate population growth, minimizing adverse economic, social, and environmental effects (Kon & Santana, 2016). Such perspectives open space for the debate on adopting initiatives that are sensitive to development and sustainability. Thus, the emerging term is that of *smart cities.*

Batty et al. (2012, p. 486) present that "the term *smart* is peculiarly American in that it is widely used in everyday speech to refer to ideas and people who provide intelligent *insights,* but it has been adopted more recently in urban planning through the cliché *smart growth*". Therefore, smart growth is related to a movement used by managers, policy makers and urban planners with the objective of achieving greater efficiency for local development.

According to Harrison and Donelly (2011), the concept of smart cities dates to the late 1990s with the smart growth movement, which aimed to defend new policies for urban planning. For the authors, the term is linked to its use by technology companies such as IBM, Siemens, and Cisco, related to the application of complex information systems that integrated urban operations and services, such as the transportation and distribution of electricity. Evolutionarily, the term came to be adopted to express the forms of innovation, technology, planning and operational development of cities.

In the theoretical field, the study of cities has presented itself based on competing paradigms. According to one paradigm, cities are presented as disordered systems. Nevertheless, according to the most recent paradigm, cities are presented as complex systems that express "innovation, tolerance, diversity, novelty, surprise and, above all, for economic prosperity" (Batty, 2008, p.1). This seems to be the concept most aligned with the term smart city (Batty, 2010; Harrison & Donelly , 2011).

However, the literature shows that there is no consensus regarding the concept of smart cities (Neirotti et al. 2014; Alves, Dias, & Seixas, 2019). For Hollands (2008), the term smart city has a degree of subjectivity and has been mistakenly confused with other terms of innovation and creativity, such as: cybernetics, knowledge cities, connected cities and digital cities.

However, a smart city is one that should improve the citizen's quality of life. This quality will be achieved by including in planning initiatives the construction of a technological infrastructure for the improvement of services (Caragliu, Del Bo, & Nijkamp, 2013; Dameri, 2013; Harrison et al., 2010). Washburn et al. (2009) and Weiss et al. (2015) corroborate this

understanding by emphasizing that information technology is the point of optimization for the use of city infrastructure.

According to Chourabi et al. (2012), a smart city is related to aspects of digital inclusion, sustainability and the generation and acquisition of knowledge. Roughly speaking, the characteristics of a smart city are endorsed in the construction or integration of an urban space, focusing on technology, integrated with the environment, enabling the construction of physical and digital mechanisms capable of bringing benefits to people. It is therefore understood that smart cities can also be focused on concepts adjacent to sustainable development (Trindade et al., 2017).

By adding sustainability, some authors extend the concept to improve the use of resources such as water and electricity and promote the city's economic growth (Caragliu et al. 2013; Dameri 2013). For Ahvenniemi et al. (2017), this fact is related to the objective of smart cities to use technological innovation and improve their sustainability. For Trindade et al. (2017), the term smart city is comprehensive and goes beyond the definitions themselves. Therefore, these are just some of the aspects considered for the formation of the idea of how a city can be characterized as intelligent (Kon & Santana, 2016).

In fact, the lack of unanimity in the conceptualization of smart cities is still not the big gap found in the literature. Beck and Conti (2021) emphasize that this gap is related to the fact of explaining what is behind the intelligences of cities. Thus, Beck and Conti (2021) present a study by which the constructs capable of explaining and filling this gap are investigated. From a narrative review of publications about smart cities aligned with theories of innovation, marketing and public administration, the authors arrived at three existing constructs to explain the phenomenon and that their interconnectivity makes cities more likely to achieve urban intelligence: a) urban innovation, b) urban governance, c) smart development. Figure 1 presents the information for each construct.

Figure 1

Constructs for Urban Intelligence

Construct	Definition
urban innovativeness	Constructs from the marketing and innovation literature can be used in cities to make them smarter, more innovative, and then create value for citizens and all types of urban stakeholders. In other words, urban innovation uses marketing theories of places and innovation to make the city an object to be explored by urban actors and the government, causing social and urban transformations.
urban governance	There are three main connected points in the governance of smart cities: first, the use of constructs related to sustainability, innovation and strategic management by the public administration; second, the use of Information and Communication Technologies (ICT) as a communication tool among urban

Construct	Definition
	actors, such as the promotion of electronic government and values related to transparency and accountability; and third, the importance of stakeholder involvement in decision-making processes.
smart development	Smart urban development synthesizes what has been worked on in the literature on urban development and studies and includes the role of ICT in dealing with challenges related to the urban agenda.

Source: Adapted from *The Role of Urban Innovativeness, Smart Governance, and Smart Development in the Urban Smartness,* by Beck, DF and Conti, D., 2021, pp 141-151.

Cities have been challenged to present strategic instruments that can compare them and, above all, improve their competitiveness. Giffinger and Gudrun (2010) presented six relevant characteristics or dimensions that provide competitive advantages. They are economy, people, governance, mobility, environment, and life. In the smart economy aspect, one must observe the competitive conditions related to the innovative spirit, entrepreneurship, economic image and trademarks, productivity, labor market flexibility, international immersion, and the ability to transform. In the smart people dimension, the human and social capital related to the level of qualification, affinity for lifelong learning, social and ethical plurality, flexibility, creativity, cosmopolitan openness, and participation in public life are analyzed.

With regard to smart governance, Giffinger and Gudrun (2010) present that it is possible to verify government participation in decision-making, public and social service, transparent governance, strategies and political perspectives. In the smart mobility dimension, transportation and information technology are analyzed, mainly local accessibility, national and international accessibility, availability of technology and infrastructure, and sustainable, innovative and safe transportation systems. In the smart environments dimension, natural resources related to absence of pollution, protection of the environment, and management of natural resources are observed. And finally, in the smart life dimension, one seeks to provide people with quality of life in terms of cultural facilities, health conditions, individual safety, quality housing, educational facilities, tourism and social cohesion.

Batty et al. (2012) indicate that in addition to the economic part, smart cities must consider the social conditions of citizens to improve the quality of life. This is how large companies such as IBM, Microsoft, Cisco have used their know-how to develop technologies, from infrastructure to software services in order to improve smartness in cities. Therefore, the new take on urban planning has the understanding that companies and organizations and their spatial behavior play a crucial role in new models of cities.

It is in this context of synergy of urban actors (technology, infrastructure, and people) that the literature has addressed smart cities. In this regard, Ahvenniemi et al. (2017) emphasize the existence of two currents for the current discussion of smart cities: the first is focused on Information and Communication Technology (ICTs) and other technologies; and

the second addresses orientation towards people, this one being less represented. Studies such as Beck et al. (2020); Monfaredzadeh and Krueger (2015); Radziejowska and Sobotka (2021) corroborate this, by identifying that technological or infrastructure aspects have taken priority over the social dimension of cities, that is, people.

As a social dimension of smart cities, the inclusion of citizens in the urban planning process is inferred from the interaction of ICTs with social (cultural) values to meet their needs with positive and efficient welfare policies related to housing, mobility, work etc. (Beck et al. (2020). It is worth mentioning that ICTs are important instruments in the consolidation of smart cities and not a "panacea for all the ills of urban development" (Michelam et al. 2020, p. 17).

In this way, the holistic view, through which the behavior of human actors provides information and data for decision-making through technological arrangements, can categorize the social dimension of a smart city (Beck et al., 2020). In fact, the participation of social capital in the construction of these cities has shown efficient alternatives for urban development, based on the management of policies and the use of information technologies capable of influencing the construction of the infrastructure necessary to face social problems (Beck & Conti, 2021).

Innovation Policy and urban intelligence in the Federal District

Cities have become intelligent because of a massive proliferation of technological mechanisms that can automate functions that used to be routine for people, structures and that have allowed the monitoring, analysis and planning of cities, aiming at efficiency and improving the quality of life of their citizens. In this sense, the notion of intelligence in cities is aligned with great challenges to relate infrastructure with operation and planning that make them truly intelligent. Therefore, Batty et. al (2012) identify that this perspective explores the idea of the city as an environment of technological change.

The new perspectives of global growth are based on development which, in its turn, is based on innovation, knowledge, and smart growth. This convergence is the adoption of innovation models and strategies for smart environments (Komninos, 2016). Schaffers et al. (2011) report that, from the insertion of participatory innovation in processes and systems, a city starts to make use of an intelligent environment and adapts to face the challenges of compliance between socioeconomic development and quality of life.

Notwithstanding this, Harrisson and Donnelly (2011, p.3) have already shown that the development of urban models, through which one sees how cities work and their intelligence capacity, has several times been confused with the concept of "any form of technology-based innovation in the planning, development and operation of cities".

The new era of digital transformation is based on a greater effort of global cooperation between economies to accelerate the learning process between technology and innovation, especially in emerging economies (Menelau et al., 2019). In this context, a sequence of events defined the evolution of Brazilian technological, scientific, and intellectual development. Such events range from the creation of the National Council for Scientific and Technological Development (CNPq), to the attempt to insert innovation mechanisms with the creation of the Innovation Law, *Law nº 10.973 (2004),* and to the arrival of *Law nº 13.243 (2016),* which promoted the enactment of the legal framework for innovation, later regulated by *Decree No. 9,283 (2018*). For Rauen (2016), these new national strategies were driven by the need for development that would generate internationally competitive possibilities.

In this new process, through which cities start to compete more effectively, there is extreme importance in promoting the capacity for learning and innovation supported and motivated by investment in both human and technological capital (Neirotti et al., 2014). In this regard, Monfaredzadeh and Krueger (2015, p. 1113) state that a "city is smart when investments in human and social capital and traditional (transportation) and modern (ICT) communication infrastructure drive sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory governance".

In view of this, it is important to implement an innovation model based on the triple helix (*Triple Helix University Industry government Relations)*, in which universities, government and companies are present. Therefore, the formation of this alliance presents itself as a basic recipe for the development of an innovation ecosystem, in which the State assumes the central role in the articulation of the system (Minghelli, 2018). In this way, by redefining the interaction of social actors in the process of technological innovation and economic efficiency, in line with the needs of the population, collaboration is achieved in the development of a smart city (Monfaredzadeh & Krueger, 2015; Beck et al., 2020)

The instruments to encourage research and development in companies have limited applicability mainly due to their institutional and bureaucratic nature (Cavalcante, 2010). According to Weiss et al. (2017), this close collaboration between the sectors can face and make viable the strategies for implementing smart cities in Brazil. From this perspective, the Federal District, with the adoption of *District Law No. 6,140 (2018)* and more recently with the enactment of *Law No. 6,620 (2020)*, established its regulatory environment for the development of science and technology, which is intended to promote actions to attract companies with technological characteristics.

From a new strategy, the Federal District started to focus on the implementation of technology parks, which, for Duarte (2005), represents one of the first urban arrangements of the new intelligent society and concentrates the innovative processes and articulation of the scientific, business, financial, and political sectors. The Federal District has two technology

parks. The first is the Science and Technology Park of the University of Brasília (PCTec / UnB), an innovation environment at the University of Brasília, created by *Resolution No. 14/2007* of the University Council (CONSUNI). The second is the Brasília Technological Park, which was opened in 2019 with the aim of stimulating entrepreneurship focused on new technologies to develop the local economy. The project, which was supported by the *Fundação de Apoio à Pesquisa do Distrito Federal* (FAPDF) and the *Banco de Brasília* (BRB), aims to revive the Organic Law that stipulates that Brasília needs to be a center for technological development.

The Innovation Law provides for measures to encourage innovation and scientific and technological research in the Federal District (*Law No. 6,140, 2018*). FAPDF is responsible for supporting and promoting scientific, technological and innovative development. Law *No. 6,140/2018* authorizes FAPDF to hold a minority interest in the capital of a specific purpose private company to obtain a product or innovation in return for the grant awarded. Among the perspectives for the future exercise of FAPDF is the objective of transforming Brasília into the first smart city in Brazil and Latin America. In 2020, the institution included 10 (ten) initiatives that are in progress, one of them with a view to implementing studies and projects for the development, demonstration and evaluation of technological solutions for smart cities (Fundação de Apoio à Pesquisa do Distrito Federal [FAPDF], 2020).

Among the initiatives, the city established, in October 2020, the Master Plan for Technologies for the Smart City (PDTCI) and the *Brasilia Inteligente* project, which has as its general objective

> To establish conditions so that the Administrative Regions of the Federal District are committed to sustainable urban development and digital transformation in its economic, environmental and sociocultural aspects, that act in a planned, innovative, inclusive and networked way, promote digital literacy, collaborative governance and management and use technologies to solve concrete problems, create opportunities, offer services efficiently, reduce inequalities, increase resilience and improve the quality of life for all people, ensuring the safe and responsible use of data and of information and communication technologies (Secretariat of Science, Technology and Innovation [SECTI], 2020).

It is worth noting that the Federal District is composed of 33 administrative regions "whose physical boundaries define the jurisdiction of government action for the purposes of administrative decentralization and coordination of public services" (Governo do Distrito Federal [GDF], 2020). Next, the methodology used to diagnose the current state of the economy and the innovative capacity of the administrative regions that make up the Federal District will be presented.

Methodology

A qualitative, exploratory-descriptive approach was used, with documents extracted from the Federal District Government sites. The qualitative bias was performed using the content analysis technique (Bardin, 2008; Weber, 1990). According to Silva and Fossá (2015),

the content analysis technique allows for methodological rigor in the interpretation of data from two poles: objectivity and subjectivity. In this way, the steps for content analysis were followed, with the reading and choosing of documents and the interpretation of the collected material (Silva & Fossá, 2015).

The secondary data collected were obtained from official government databases and document analysis of the Pluriannual Plan (PPA) and Budget Balance. It is worth mentioning that the PPA consists of a tool for planning government activities for the medium or long term, aiming to coordinate its actions through guidelines, goals, and objectives (Cavalcante, 2007). These documents made it possible to identify and analyze the main administrative functions that support the industry, innovation, and infrastructure of the Federal District. The focus of the research was on Science, Technology and Innovation, a new legal framework for innovation, as well as the productive force, the economic engine of a smart city.

As in Neirotti et al. (2014) and Giffinger and Gudrun (2010), the study sought to analyze the dimension or domain that can influence the best practices of a smart city. Among the proposed metrics, the economy dimension was chosen. The smart economy of a city can be measured by its entrepreneurial environment and actions related to the dimension of incentives for companies to develop technological solutions. Regarding economic governance, government expenditure was understood as the use of city resources (Kon & Santana, 2016). The functions analyzed in the governance domain are understood as the requirements that are necessary to build the industrial development of the city. These are the functions of industry, energy, transportation and education, set out in the Multi-Year Plan (PPA) 2016 to 2019 (Government of the Federal District [GDF], 2015). In addition to the expenses, their settlement was analyzed, that is, the verification of the right acquired by the creditor before payment.

First, metrics were established for evaluating the Federal District in relation to innovation and sustainability in the business sector. The metrics met the definition that describes economic dimensions to verify the conditions of technological intensity of the administrative regions. For the purposes of strict alignment with the theme, actions arising from functions directly related to activities affected or regulated by the government, promoting industrial development, were defined. For this study, the years 2016 to 2019 of the PPA were covered.

The same sources were used to estimate the difference between the resources that were made available from the public budget to achieve each goal and the effective application of the resource. Thus, it was possible to understand whether the amounts committed to government expenditure met the programs with a view to the goal. An analysis of what was planned and budgeted was carried out, *vis-à-vis* what was effectively carried out, that is, resources spent, and goals achieved.

To identify the productive force of the Federal District, a taxonomy was developed by the Organization for Economic Cooperation and Development (OECD), which is based on the analysis of sectors of activity, serving as studies of economics of innovation (Galindo-Rueda & Verger, 2016). The sectors of activity are recognized through the classification system of economic data developed by the United Nations Statistics Division in 1948, the *International Standard Industrial Classification of All Economic Activities* or *Clasificación Industrial Internacional Uniform* (CIIU/ISIC), which is constantly revised and improved with a view to being an instrument of harmonization in the production and dissemination of economic statistics. Thus, companies were grouped and classified into levels of intensity in research and development, according to the work of Morceiro (2019) and Galindo-Rueda and Verger (2016) who used OECD models to classify levels of economic and technological sectors, as follows:

a) high intensity: manufacturing (pharmaceuticals and computing, electronics and optical products) and non-manufacturing (scientific research and development);
b) medium-high intensity: manufacturing (chemicals, electrical machinery and equipment, machinery and equipment, motor vehicles, other transportation equipment) and non-manufacturing (publishing and publishing integrated with printing, technology and other information services).
c) medium intensity: manufacturing (rubber and plastic products, other non-metallic minerals; basic metallurgy; miscellaneous products; maintenance, repair and installation of machinery and equipment).
d) medium-low intensity: manufacturing (food, beverages and tobacco; textiles, clothing and accessories; leather and related products, wood products; cellulose and paper; pressing and manufacture of recordings; coke and petroleum derivatives; metallic products, except machinery and equipment; furniture), non-manufacturing (extractive industry; telecommunications; professional, scientific and technical activities);
e) low intensity: non-manufacturing (agriculture, livestock, forestry and fishing; electricity and gas, water, sewage and urban cleaning; construction; commerce; transportation, storage and mailing; warehousing and food; audiovisual activities and broadcasting activities; financial and insurance activities; real estate activities; administrative activities and complementary services; arts, recreation, domestic services, associative organizations and other services).

Information about the companies was taken from the Federal Revenue *website,* called Cnpj.info, corresponding to the 2018 financial year, totaling 263,679 business entities. Data were standardized using the *Quantum Geographic program. Information System* (QGis),

allowing for an inferential analysis through statistical techniques, as well as identifying a productive "unique identity" of administrative regions (AR). The data were adjusted, especially regarding the Postal Address Codes (CEP) of the companies, and the organizations that fell into one of the following categories were excluded: legal institutions, public administration, state-owned enterprises, and mixed-capital companies (subclassifications of business entities), non-profit entities and international organizations and other extraterritorial institutions. The database also considered the National Classification of Economic Activities (CNAE) of the Brazilian Institute of Geography and Statistics (IBGE), which has 21 sections on economic activities. Of these, section U - international organizations and other extraterritorial institutions - was excluded from the analysis, due to the legal nature of its entities.

Figure 2 presents the methodological mooring matrix used, which summarizes the work of this research. According to Teles (2001), this tool helps in exposing research decisions and definitions such as, for example, objective, data sources, survey, analysis, and form of presentation.

Figure 2

Methodological mooring matrix

Research Model	Research Objectives	Research Source	Data Collection and Analysis	Results presentation
Exploratory-descriptive analysis	Diagnose the economic aspects of the Federal District	Base and data extracted from the multiannual plan from 2016 to 2019.	Qualitative Research (survey) Content analysis of committed and settled expenses related to industry, energy, transportation, and education functions.	descriptive statistics tables and graphs
	Analyze the data of the productive force of the Federal District	CNPJ.info data	Qualitative Research (survey) Classification according to the taxonomy developed by the OECD. Content analysis of companies for adjustment according to taxonomy.	Tables and Graphs
	Map the technological intensity (productive force) by Administrative Regions	CNPJ.info data Postal Address Code (CEP) National Classification of Business Activities (CNAE)	Qualitative Research (survey). Spatial standardization with the aid of the Quantum Geographic program Information System (QGIS)	Tables and maps showing the productive force of the Federal District in terms of technological intensity (high, medium-high, medium, medium-low and low).

Source: Prepared by the authors.

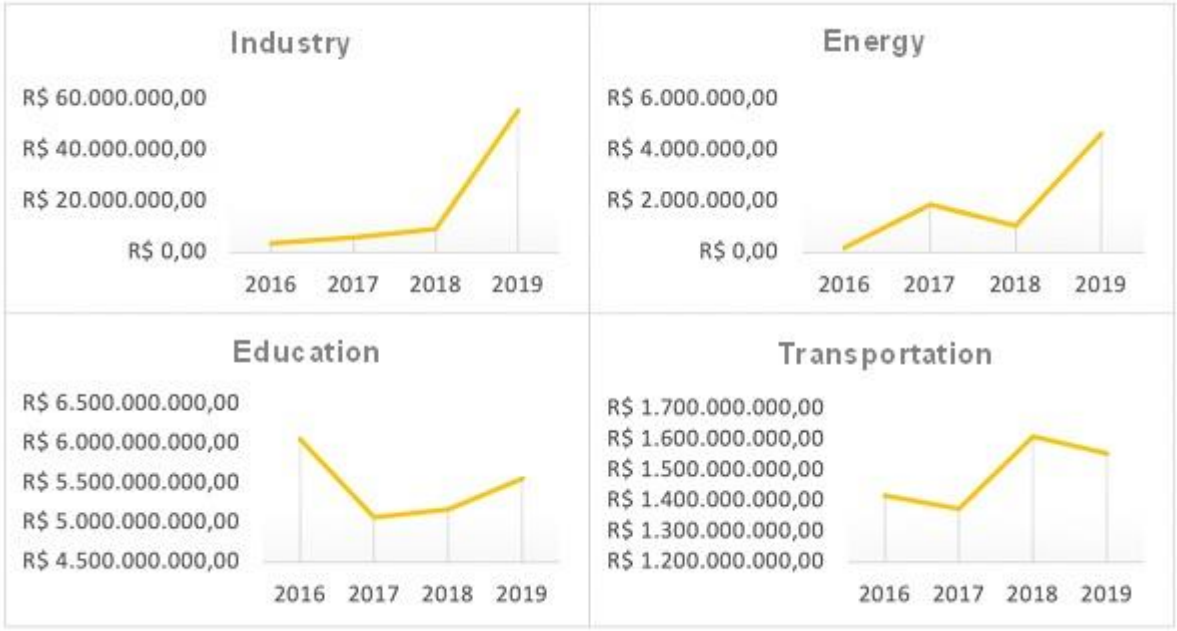
Results and discussion

Resources committed to the Federal District in relation to industrial development

For this research, the PPA from 2016 to 2019 of the Government of the Federal District was analyzed (see Figure 3). The expenses committed to the industry function are concentrated in the *Brasília Competitiva* program for all years. The objective of the program is described in the PPA as "to make Brasília competitive through public policies of sustainable development, generation of work, employment and income, and innovation". It is possible to notice a substantial increase in the expenses committed to this program in 2019, equal to 83.30%. That same year, *Brasília Competitiva* had its expenses committed to 10 calls for tenders and other agreements and partnerships with the FAPDF (Fundação de Apoio à Pesquisa do Distrito Federal [FAPDF], 2019), a local research funding institution.

Figure 3

Federal District Resource Estimates



Source: Elaboration based on PPA data from 2016 to 2019.

The two programs described in energy expenditure propose the promotion of people's citizenship and mobility. The program, with the second proposal, concerns integrated mobility and sustainability, and was not present in the 2019 plan. As with expenses for industry, 2019 was also the year with the largest amount spent on the energy function, with the variation compared to 2018 equal to 77.19%.

Transportation expenses fluctuated, ending with a drop in 2019. The highest amount spent was in 2018, with a variation of 3.04% in relation to 2019, distributed across several

programs. The resources spent on education are distributed across seven programs. The numbers show us, from 2016 to 2017, that the value had a drop of 16.29%. The variation between 2017 and 2019 was 8.73%, halving the difference between previous years.

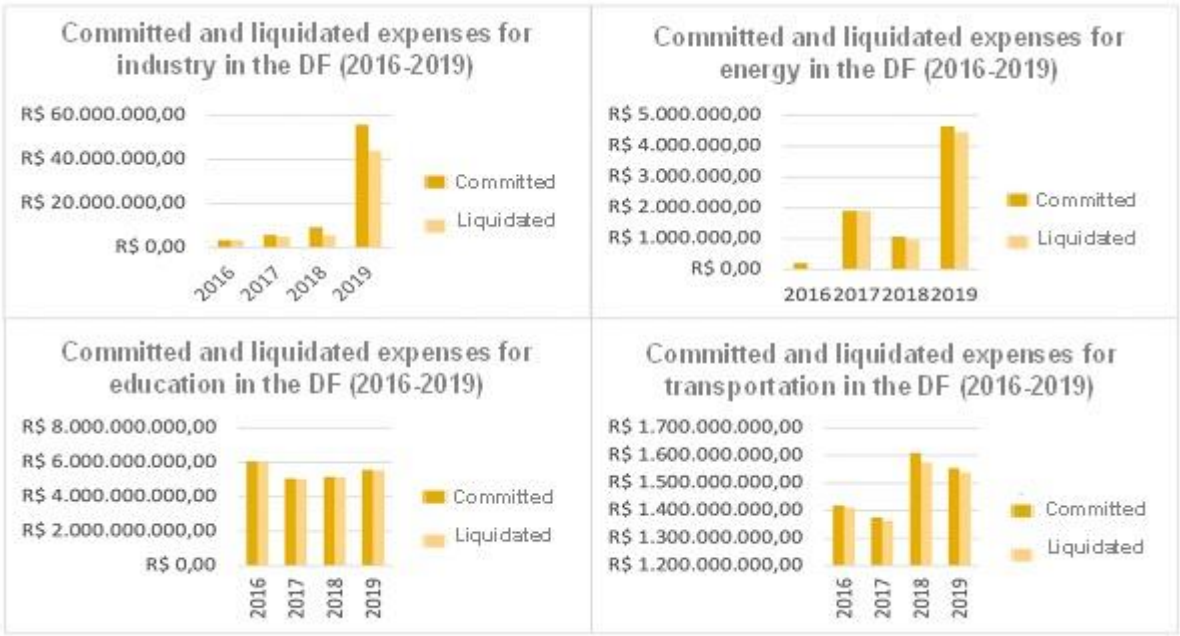
According to the data, the year with the highest commitment of expenses was 2018. The arithmetic average of expenses for the four functions considered shows us that from 2016 to 2019 R$18,641,474.61 were committed to expenses in the industry function, R$1,955,828.17 for energy, R$5,465,308,888.61 for education and R$1,489,559,069.10 for transportation.

Likewise, the calculation of the difference between committed and settled expenses was made for the same metric and period. Therefore, in order to achieve this objective, data from the 2016-2019 PPA were used to analyze what was planned and budgeted *vis-à-vis* what was actually carried out. The analysis of the amounts committed sheds light on the weighting and planning of actions, while the analysis of the amounts settled shows us the commitment to planning (see Figure 4).

The data show that, for most functions per year, there is uniformity between the amounts committed and paid. For the industry function, liquidation expenses were above 60% for all years. The lowest settlement expense of the amount pledged was 61.48% in 2018. In 2019, the settlement expense was equal to 78.74%, while in 2017 and 2016 it was over 85%. In 2016, expenditure on the settlement of the amount pledged for energy was the lowest of all years and functions, equal to 6.44%. In that year, the funds of R$13,163.24 were allocated to the expansion of the public lighting network, which was fully liquidated, and R$191,226.71 to the expansion of public lighting points, which were not liquidated. In the following year, however, there was 100% settlement of the amount pledged and it was higher than 85% in the years 2018 and 2019. The resources committed to education had settlement of more than 99% in all years, like the settlement of the amounts pledged for transportation, which was higher than 95% for all years.

Figure 4

Estimation of the Difference between the Committed Resources of the Federal District



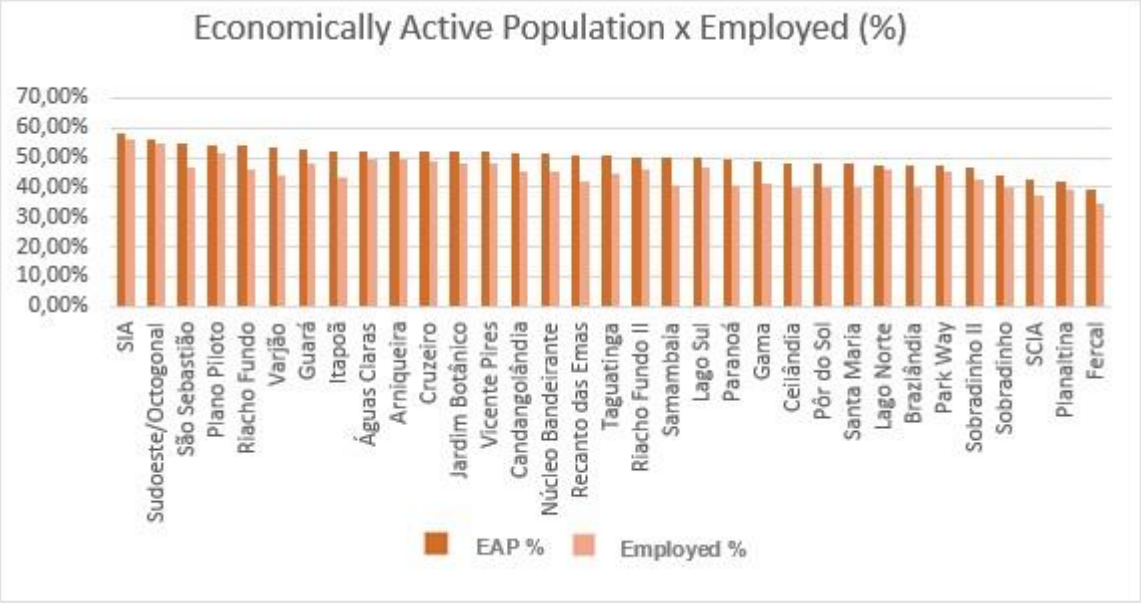
Source: Elaboration based on PPA data from 2016 to 2019.

Employment

Quality of life also includes assessing the situation of the Economically Active Population (EAP) and those who are employed. The EAP comprises the potential manpower that the productive sector can count on. Employed people are those who, in each period, worked or had work (Instituto Brasileiro de Geografia e Estatística [IBGE], 2018). The biggest difference between the percentages of EAP and of Employed people is in the administrative region Varjão, equal to 9.68%. The administrative region with the highest percentage of EAP is the Industry and Supply Sector (SIA, in Portuguese), with 57.84% and the difference is 1.80% in relation to the number of people employed. For all other regions, this difference is less than 10% (see Figure 5).

Figure 5

Active Population x Employment by the Administrative Region of the Federal District.



Source: Prepared by the authors

The initiative aims to reach 400 companies in two years, through consulting services that increase productivity, efficiency, and innovation, and with that, favor the transition to the precepts of industry 4.0. The methodology that consists of rapid, low-cost, and high-impact interventions is the same as the federal program *Brasil Mais Produtivo*.

It is worth mentioning that in the intelligent governance item, also highlighted by Giffinger and Gudrun (2010), the data allow us to move towards a reading of political strategies and perspectives, such as transparent governance and public social services. In the Federal District, its main characteristic is that it has the main federal public bodies and the local government itself.

Mapping of Technological Intensity

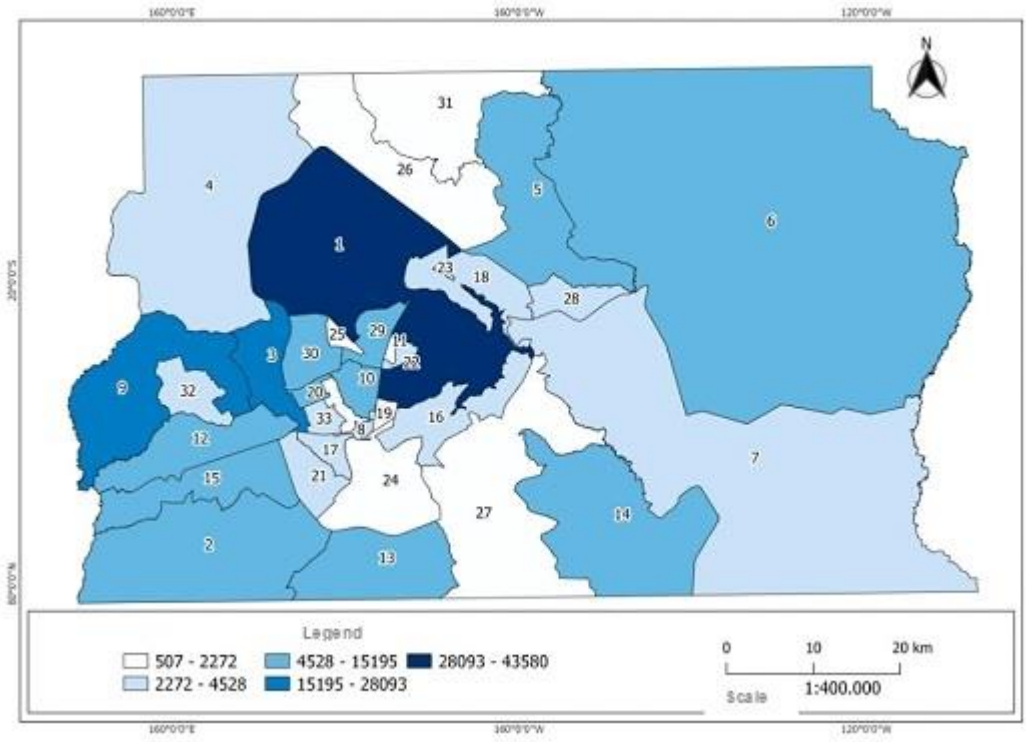
For Batty et al. (2020), understanding smart cities also involves understanding the interaction between the market and the performance of companies and organizations. These agents are of special importance for new models of complex systems in a city, such as providing hardware, software and technological data products and services for cities to be more efficient. In this way, knowing the productive business environment of the Federal District allows us to observe how the construction of a smart city can occur.

Based on the original data from the Federal Revenue Service for 2018, it was possible to generate a specific spatial map of the productive trend in the region (see Figure 6). The spatial result permits the identification of the areas that have lower or higher values, indicating

results of business behavior. The largest concentration of business entities is in the Plano Piloto, reaching 43,580, followed by Ceilândia with 24,959, representing respectively 16.53% and 9.47% of the total of 263,679 (see Table 1 on the number of companies per level of technological intensity in the administrative regions of *the Federal District)*.

Figure 6

Geographic Location of Productive Entities in the Federal District



Source: Created by the authors with data from *Cnpj.info* of the Federal Revenue.

In the Federal District, there are companies at all levels of technological intensity: high, medium-high, medium-high, medium, medium-low and low. The Plano Piloto concentrates 49 of the high technological intensity companies and 2,971 of the medium-high technological intensity companies, representing 43.75% of the total of 112 and 38.51% of the total of 7,714, respectively. Also in the Plano Piloto, medium-low intensity and low technological intensity companies are also present in greater numbers, representing 22.82% of the total of 36,947 and 14.80% of the total of 214,094, respectively. Medium-technology companies are present in greater numbers in Ceilândia, representing 11.28% of the total of 4,812.

The main economic activity [1]of the Plano Piloto administrative region is civil service, while the second economic activity is commerce. The stability and high salaries offered by the

[1] The information from the CNAE sections by administrative region can be analyzed in a supplementary document.

Federal District are responsible for most of the wealth produced in the region, which helps keep the Gross Domestic Product (GDP) elevated and the *per capita income* high. In the Plano Piloto, there are 43,580 business entities, among which the most frequent economic activities are on the list of section G - commerce: repair of motor vehicles and motorcycles. This corresponds to 24% of the total (10,413 entities), certainly because it comprises various retail and wholesale businesses. This amount is followed by sections M - professional, scientific, and technical activities, with 6,936 business entities (16%), N - administrative activities and complementary services- with 4,628 business entities (11%) and I - accommodation and food - with 4,432 business entities (10%).

Regarding the business entities, the Plano Piloto region has 73% of its entities classified as having low technological intensity (31,681). This high percentage is due to the nature of the activities carried out in the region. It is worth mentioning that the activities of sections C - manufacturing industries, D - electricity and gas, G - trade, repair of motor vehicles and bicycles, J - information and communication - and M - professional, scientific, and technical activities - may present a higher degree of technological intensity, which was not possible to observe in the analyzed region. Thus, 19.3% (8,395) entities of medium-low technological intensity are found in sections C - manufacturing industries - (1,188), J - information and communication - (297) and M - professional, scientific, and technical activities - (6,910). Section C - manufacturing industries - totally concentrates the 446 medium-intensity business entities, which corresponds to 1.02%. Of the 2,971 medium-high technological intensity entities, represented by 6.82%, 51 entities belong to section C - manufacturing industries - and 2,920 to section J - information and communication. In this region, there are 49 entities of high technological intensity, belonging to sections C - Manufacturing industries - (23) and M - professional, scientific, and technical activities - (26), corresponding to 0.11% of the total of analyzed entities.

Meanwhile, the administrative region Ceilândia, considered the most populous region in the Federal District, with 432,9217 inhabitants in 2018, concentrates the largest precast, food and furniture factories. With 24,959 business entities, Ceilândia has a higher frequency of activities related to section G - commerce: repair of motor vehicles and motorcycles. Commercial units represent 40% (9,877 units) of the region's economic operations due to the number of wholesalers and retailers. On the other hand, the entities that carry out activities in the sections “other activities and services” represent 12% with 2,993 units. Then, there is the presence of entities for sections I - accommodation and food - , with 10% (2,572 units) and C - manufacturing industries - with approximately 10% (2,375 business entities). The classification of the entities by sectors of the economy allowed the observation that in Ceilândia the predominance is in the entities of the commercial sectors.

Of the analyzed entities, it was possible to verify that 49.10% are classified in this sector. This corresponds to 12,254 units. For entities operating in the service sector, there are 38.15% of units (9,522) and in the industrial sector this number approaches 12.75% (3,183). Therefore, the highest frequency of economic activities corresponds to those classified by section G - trade, repair of motor vehicles and motorcycles. In view of this, it is observed that, due to the nature of the activities performed in the region, the number of entities with low technological intensity is significant. It corresponds to 84.34% with 21,050 of the analyzed economic agents. From the same point of view, it turns out that 3,056 entities (12.24%) classified as medium-low technological intensity are found in sections C - manufacturing industries - (1,784), J - information and communication - (64) and M - professional, scientific, and technical activities- (1,206). Section C - manufacturing industries - concentrates the 543 medium-intensity business entities, which corresponds to 2.17% of the total. Of the 309 entities (1.24%) classified as medium-high technological intensity, there was a dispersion by section C - manufacturing industries - with 47 units and by section J - Information and communication - with 262. In this administrative region, there is 1 entity of high technological intensity, belonging to section C - manufacturing industries.

Table 1

Level of Technological Intensity by Administrative Region of the Federal District

RA	Name	Technological Intensity Level					
		High	Medium-High	Average	Medium-Low	Low	Total Companies
I	1 Plano Piloto	49	2,971	446	8,433	31,681	43,580
II	2 Gama	4	176	246	1,474	9,858	11,758
III	3 Taguatinga	3	650	499	3,411	23,530	28,093
IV	4 Brazlândia	1	31	91	473	3,502	4,098
V	5 Sobradinho	5	334	310	1,486	9,583	11,718
VI	6 Planaltina	2	90	182	1,167	10,066	11,507
VII	7 Paranoá	0	35	70	400	3,507	4,012
VIII	8 Núcleo Bandeirante	11	111	78	531	3,073	3,804
IX	9 Ceilândia	1	309	543	3,056	21,050	24,959
X	10 Guará	2	377	212	1,656	8,771	11,018
XI	11 Cruzeiro	0	114	46	318	1,687	2,165
XII	12 Samambaia	0	162	313	1,939	12,781	15,195
XIII	13 Santa Maria	6	117	225	1,183	7,833	9,364
XIV	14 São Sebastião	0	82	138	813	6,527	7,560
XV	15 Recanto das Emas	0	71	197	1,040	7,362	8,670
XVI	16 Lago Sul	4	148	37	958	2,956	4,103
XVII	17 Riacho Fundo I	0	66	80	508	3,151	3,805

RA	Name	Technological Intensity Level					
		High	Medium-High	Average	Medium-Low	Low	Total Companies
XVIII	18 Lago Norte	3	190	39	547	1,957	2,736
XIX	19 Candangolândia	0	19	35	163	1,217	1,434
XX	20 Águas Claras	3	569	138	1,649	7,388	9,747
XXI	21 Riacho Fundo II	0	29	99	431	3,054	3,613
XXII	22 Sudoeste/Octogonal	2	271	40	703	3,512	4,528
XXIII	23 Varjão	0	4	13	81	604	702
XXIV	24 Park Way	1	73	33	214	897	1,218
XXV	25 Setor Complementar de Indústria e Abastecimento (SCIA)	0	16	51	232	1,973	2,272
XXVI	26 Sobradinho II	0	18	29	184	1,379	1,610
XXVII	27 Jardim Botânico	0	127	64	399	1,580	2,170
XXVIII	28 Itapoã	0	12	58	278	2,683	3,031
XXIX	29 Setor de Indústria e Abastecimento (SIA)	11	248	113	968	7,896	9,236
XXX	30 Vicente Pires	1	162	162	1,050	5,992	7,367
XXXI	31 Fercal	0	2	32	33	440	507
XXXII	32 Sol Nascente/Pôr do Sol	0	41	84	565	3,159	3,849
XXXIII	33 Arniqueiras	3	89	109	604	3,445	4,250
	Total	**112**	**7,714**	**4,812**	**36,947**	**214,094**	**263,679**

Source: Prepared by the Authors.

As for size (see Table 2), of the total of 263,679 business entities in the Federal District, 68% (178,289) are classified as micro-entities, with 66 considered high, 4,942 medium-high, 3,553 medium, 24,127 medium- low, and 145,601 low technology intensity. Most companies in the Federal District are classified as having low technological intensity, reaching a total of 214,094.

Table 2

Number of Business Entities and Technological Intensity Level

Company Size	Low	Medium Low	Average	Medium High	High	Total
micro	145,601	24,127	3,553	4,942	66	178,289
Small	11,576	1,758	105	513	21	13,973
Medium	2,255	278	7	91	5	2,636
Great	54,662	10,784	1,147	2,168	20	68,781
Total	214,094	36,947	4,812	7,714	112	263,679

Source: Prepared by the Authors.

When analyzing the activities with higher frequency that may represent the technological intensity of business entities, it is possible to verify that only activities in sections C - manufacturing industries - and M - professional, scientific, and technical activities - present a high intensity classification. For medium-high intensity, entities were observed in sections C - manufacturing industries - and J - information and communication. Of medium technological intensity, only business entities that carry out activities related to section C - manufacturing industries - were found. Additionally, as it turns out, this section was the only one that was present in almost all levels of technological intensity.

For business entities that are classified as having medium-low technological intensity, their presence was verified in economic activities of sections B (extractive industries), C - manufacturing industries, J - information and communication - and M - professional, scientific, and technical. Except for activities in sections B - extractive industries, C - manufacturing industries - and M - professional, scientific and technical activities, business entities were found in all other sections of economic activities with a low degree of technological intensity. Table 3 presents a summary of the distribution of business entities according to the degree of technological intensity, classified according to the sections of CNAE activities analyzed in this study (information complementary to the table can be requested from the authors).

Table 3

Distribution of Technological Intensity of Business Entities by Section of Economic Activity

CNAE section	Low	medium-low	Average	medium-high	High
A - Agriculture, livestock, forestry production, fisheries and aquaculture	670	0	0	0	0
B - Extractive industries	0	113	0	0	0
C - Transformation industries	0	14,871	4,813	441	66
D - Electricity and gas	73	0	0	0	0
E - Water, sewage, waste management and decontamination activities	542	0	0	0	0
F - Construction	20,633	0	0	0	0
G - Commerce; repair of motor vehicles and motorcycles	93,303	0	0	0	0
H - Transportation, storage and mail	11,451	0	0	0	0
I - Accommodation and food	27,623	0	0	0	0
J - Information and communication	1,390	1,055	0	7,275	0
K - Financial, insurance and related services activities	3,739	0	0	0	0
L - Real estate activities	3,287	0	0	0	0
M - Professional, scientific and technical activities	0	20,914	0	0	46
N - Administrative activities and complementary services	18,363	0	0	0	0
R - Arts, culture, sport and recreation	4,350	0	0	0	0
S - Other service activities	27,461	0	0	0	0
T - Domestic services	1,264	0	0	0	0
TOTAL	**214,149**	**369,53**	**4,813**	**7,716**	**112**
%	81.20	01.14	1.82	2.93	0.04

Source: Prepared by the authors.

Competitiveness has become an important variable in the development of cities, especially in the economic field. According to Harrison and Donelly (2011), cities realized that the inclusion of smart models, in several areas of their planning, would act as a main point in competitive success. Thus, a smart city becomes an attractive environment. The data collected allow us to verify that there are only 112 business entities classified as having high technological intensity (according to the OECD classification). In this way, the local government has expanded public policies to encourage the attraction of new innovative entrepreneurs through projects and laws, in line with the objective of fostering the *Brasilia Inteligente* project.

In this context, the results corroborate Duarte (2005) that the Federal District has focuses for innovation activities and, consequently, one of the first urban arrangements for an intelligent society. It remains to be determined whether or not this is one of the best strategies. Nevertheless, in terms of the urban characteristic of the Federal District, the administrative regions have administrative decentralization and coordination of public services, but financial planning is at the macro level, that is, it encompasses the entire federative entity. Thus, the strategic vision of creating a smart city has positive possibilities of success.

However, it is valid to readopt the understanding of Batty et al. (2011) that smart cities should not only be tied to the economic context, but also to the social conditions for quality of life. In this way, there is a need for a constant incentive for companies in the Federal District to assume the role of innovative agent and add value to the process of intelligent models, such as innovative creations that allow their better competitiveness and, thus, increase the urban intelligence process, not analyzed here in the context of cause and effect.

In other words, the understanding of Beck and Conti (2021), that urban innovation is a construct capable of defining a smart city, allows the inference that the Federal District is still in an incipient process if only this construct is analyzed. This is due to the results that present a very small portion of companies and organizations classified in levels of technological intensity above an average standard of innovation.

In fact, the factors mentioned by Giffinger and Gudrun (2010), for the smart economy item, address the characteristics of innovative spirit, entrepreneurship, and productivity. The present work was limited to verifying the productive force that sustains the technological intensity of the Federal District, according to the OECD classification. From this mapping, it will be possible to analyze the social and human conditions of the 33 administrative regions, regarding the level of qualification, creativity and participation in public life, for example, since these are also factors for the smart city approach, as cited Giffinger and Gudrun (2010).

Conclusions

The present work aimed to diagnose the economic aspects and the productive force of the administrative regions of the Federal District, in the light of the characteristics that make up the concept of smart city. Considering that the work had a qualitative and exploratory nature, the objective was achieved, since knowing the types of companies and their potential, as well as the economic and innovative competences in the Federal District, allows this study to be replicated. Thus, the work becomes original and of paramount importance since it is the first study with the application of OECD concepts and data collection from these companies.

It is worth remembering that the Federal District is a federative entity that has unique characteristics that set it apart from other Brazilian entities, as it is composed of a cluster of policy-making bodies that execute the administrative and fiscal management of the country. Furthermore, the administrative decentralization of its regions makes academic studies incipient. In this way, the research presents as practical implications a general knowledge of the Federal District's reality regarding the perspectives of innovation intelligence and urban governance, studied here from the perspective of the economy and the productive force. Therefore, it allows for a new perspective for decision-making by public managers in the field of policies aimed at economic and social actions toward the realization of a smart city.

It is also understood, as a practical implication, that the classification of the levels of technological intensity of the projects and their spatial analysis allow for the observation of the entities in other aspects, such as their size, their sector of activity, their legal nature, their location in the administrative regions of the Federal District, in order to cross-reference data and obtain sufficient information to identify where policies should be introduced to encourage technological innovation and, therefore, competitiveness.

The theoretical implications of the research are related to the context of smart cities from the point of view of innovation. In this way, further research can: i) better explore the productive environment, especially in terms of technological intensity, in order to define the relationship between the introduction of products and services with high technological content and the construction of urban intelligence; ii) investigate the interaction of social actors (companies, government and people) in the production process aimed at improving the quality of life; iii) analyze and monitor the productive force, subsidizing information for decision making and directing resources in research and development of each administrative region, for example, urban innovation process.

What makes a smart city is related to improving the population's quality of life in harmony with governance, economy, mobility, environment, and smart living. When evaluating the governance and economy dimension, it can be concluded that the Federal District responds positively to the commitment to the goals proposed in the government plan,

promoting governance and smart economies. This is because the Federal District pledges amounts to its expenditures aimed at industrial and technological development, settles payments (verifies and liquidates the right acquired by the creditor after delivery of the service or purchase) and, in addition, has regulations in the law to encourage innovation.

The expenses were evaluated based on the industry functions and its main program - *Brasília Competitiva*. This one had the support of its Fundação de Apoio à Pesquisa to encourage research and development. For energy, education, and transportation expenses, 2019 was the period with the highest committed expenditure. The settlement of expenses fluctuated, but for all years and functions it was higher than 60%, except for the settlement of energy commitments, which in 2016 was equal to 6.44%. That year, the action that would expand the public lighting network was not carried out. For transportation and education, liquidation spending was over 95%. Due to the results obtained, the authors that the Federal District, in order to achieve the desired smart city goal, make plans to improve the population's quality of life in relation to access to basic services at the level of the economically active population, with special attention to low-middle and low-income administrative regions.

It is observed that most sectors of economic activity belong to the group of companies with low technological intensity, which have little investment in research and development. The only sectors which have divisions with a high level of technological intensity are in section C - manufacturing industries (specifically the pharmaceutical, computer, electronics, and optical industries) and in section M - professional, scientific, and technical activities - (research and scientific development), according to the CNAE classification.

The study points out the main existing business levels and economic activities in the Federal District. However, it is limited to a mapping of its technological intensity, not being possible to have a more accurate understanding trends of a smart city, either from the analysis of urban innovation, urban governance, or smart development. Another limitation is the fact that studies in the Federal District must consider its administrative limitations or its master plan.

Thus, as a recommendation, new studies may: i) expand from a specific analysis on issues of transforming capacity, entrepreneurship, sustainable management of resources, among others, which may point out characteristics of an intelligent strategic vision of the productive sectors of the region; ii) study, in research companies, the existence of innovation strategies (of products, processes, marketing and organizational) that allow finding impacts of intelligent development in the region; iii) carry out a more accurate study of technological environments, observing the human, physical and financial resources allocated to scientific and technological activities; iv) analyze the result indicators and the impact indicators of Science, Technology and Innovation activities on the performance of companies or on the levels of economic and social development of the Federal District; v) verify the dissemination

of policies to increase the effectiveness of government actions for the construction of the smart city based on projects, such as the case of "*Brasília Inteligente*".

In short, the research presents social implications based on information on governmental actions to encourage improvements in the quality of life of people from their regions (information on economic aspects) to the vision of one of the urban actors (companies) in the construction of the production process, aiming at innovation and increased competitiveness. Therefore, the perspective of the actions of these actors, in a conscious and sustainable way, tends to provide an improvement in the structuring of the urban system of the city, in line with the new global perspectives of intelligent development.

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References

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities?. *Cities*, *60*, 234-245. https://doi.org/10.1016/j.cities.2016.09.009

Alves, M. A., Dias, R. C., & Seixas, P. C. (2019). Smart Cities no Brasil e em Portugal: o estado da arte. *Urbe. Revista Brasileira de Gestão Urbana*, *11*. https://doi.org/10.1590/2175-3369.011.e20190061

Bardin, L. (2008). *Análise de Conteúdo*. (L. A. R. trad.) Edições 70.

Batty, M. (2008). The size, scale, and shape of cities. *Science*, *319*(5864), 769-771. https://doi.org/10.1126/science.1151419

Batty, M. (2010). Visualizing space–time dynamics in scaling systems. *Complexity*, *16*(2), 51-63. https://doi.org/10.1002/cplx.20342

Batty, M., Axhausen, K.W., Giannotti, F. *et al.* Smart cities of the future. *Eur. Phys. J. Spec. Top.* 214, 481–518 (2012). https://doi.org/10.1140/epjst/e2012-01703-3

Beck, D. F., & de Melo Conti, D. (2021). The Role of Urban Innovativeness, Smart Governance, and Smart Development in the Urban Smartness. *Humanidades & Inovação*, 8(49), 141-151. Retrieved from https://revista.unitins.br/index.php/humanidadeseinovacao/article/view/5134

Beck, D., Da Silva Neto, W., Bezerra, A., Araújo, V., & Távora, C. (2020). Um framework teórico sobre a dimensão social da inteligência das Cidades Inteligentes. *Revista de Arquitetura IMED, 9*(2), 1-17. https://doi.org/10.18256/2318-1109.2020.v9i2.3748

Caragliu, A., Del Bo, C., & Nijkamp, P. (2013). Smart cities in Europe. In *Smart cities* (pp. 185-207). Routledge. Retrieved from

https://www.taylorfrancis.com/books/mono/10.4324/9780203076224/smart-cities?refId=c33a9907-6979-4de3-baab-db350041fc5a&context=ubx

Cavalcante, L. R. (2010). Políticas de ciência, tecnologia e inovação no Brasil: uma análise com base nos indicadores agregados. In *Instituto de Pesquisa Econômica Aplicada, Brasil em Desenvolvimento: Estado, planejamento e políticas públicas* (pp. 289-310). Brasília: Ipea. Retrieved from http://repositorio.ipea.gov.br/handle/11058/2378

Cavalcante, P. L. (2007). O Plano Plurianual: resultados da mais recente reforma do Planejamento e Orçamento no Brasil. *Revista do serviço público*, *58*(2), 129-150. Retrieved from https://revista.enap.gov.br/index.php/RSP/article/view/168/173

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., ... & Scholl, H. J. (2012, January). Understanding smart cities: An integrative framework. In *2012 45th Hawaii international conference on system sciences* (pp. 2289-2297). IEEE. https://doi.org/10.1109/HICSS.2012.615

Dameri, R. P. (2013). Searching for smart city definition: a comprehensive proposal. *International Journal of computers & technology*, *11*(5), 2544-2551. Retrieved from https://rajpub.com/index.php/ijct/issue/view/199

Decreto nº 9.283, de 7 de fevereiro de 2018 (2018). Regulamenta a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 13.243, de 11 de janeiro de 2016, o art. 24, § 3º, e o art. 32, § 7º, da Lei nº 8.666, de 21 de junho de 1993, o art. 1º da Lei nº 8.010, de 29 de março de 1990, e o art. 2º, caput, inciso I, alínea "g", da Lei nº 8.032, de 12 de abril de 1990, e altera o Decreto nº 6.759, de 5 de fevereiro de 2009, para estabelecer medidas de incentivo à inovação e à pesquisa científica e tecnológica no ambiente produtivo, com vistas à capacitação tecnológica, ao alcance da autonomia tecnológica e ao desenvolvimento do sistema produtivo nacional e regional. http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2018/Decreto/D9283.htm

Duarte, F. (2005). Cidades inteligentes: inovação tecnológica no meio urbano. *São Paulo em Perspectiva*, *19*(1), 122-131. https://doi.org/10.1590/S0102-88392005000100011

Fundação de Apoio à Pesquisa do Distrito Federal (2019 - 2020). *Relatório de gestão FAP-DF 2020*. [s.l: s.n.]. Retrieved from http://www.fap.df.gov.br/wp-content/uploads/2018/05/Relatorio-de-Gestao-UO-40201-18_01_2021_19_05.pdf

Galindo-Rueda, F.; Verger, F. (2016). *OECD Taxonomy of Economic Activities Based on R&D Intensity*. OECD Science, Technology and Industry Working Papers, n. 2016/04. Paris: OECD Publishing. Retrieved from https://www.oecd-ilibrary.org/docserver/5jlv73sqqp8r-en.pdf?expires=1614098067&id=id&accname=guest&checksum=CBF8F649E04DF73E54DA3D5E51E2D676

Giffinger, R., & Gudrun, H. (2010). Smart cities ranking: an effective instrument for the positioning of the cities? *ACE: architecture, city, and environment*, *4*(12), 7-26. http://dx.doi.org/10.5821/ace.v4i12.2483

Governo do Distrito Federal (2015). *Orientações para elaboração do Plano Plurianual 2016-2019.* Retrieved from http://www.economia.df.gov.br/wp-conteudo/uploads/2017/12/Orienta%C3%A7%C3%B5es-para-a-Elabora%C3%A7%C3%A3o-do-PPA-2016-2019.pdf

Governo do Distrito Federal (2019). *Plano Estratégico do Distrito Federal 2019-2060*. Brasília, Retrieved from http://www.economia.df.gov.br/wp-conteudo/uploads/2019/05/Book_PEDF_Plano_Estrategico_final.pdf

Harrison, C., & Donnelly, I. A. (2011). A Theory of Smart Cities. *Proceedings of the 55th Annual Meeting of the ISSS - 2011, Hull, UK*, *55*(1). Retrieved from https://journals.isss.org/index.php/proceedings55th/article/view/1703

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for smarter cities. *IBM Journal of research and development*, *54*(4), 1-16. Retrieved from https://ieeexplore.ieee.org/abstract/document/5512826.

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?. *City*, *12*(3), 303-320. https://doi.org/10.1080/13604810802479126

Instituto Brasileiro de Geografia e Estatística (2018). *Pesquisa Nacional por Amostra de Domicílios Contínua 2018.* Retrieved from https://www.ibge.gov.br/estatisticas/multidominio/condicoes-de-vida-desigualdade-e-pobreza/17270-pnad-continua.html?=&t=o-que-e

Komninos, N. (2016). Smart environments and smart growth: connecting innovation strategies and digital growth strategies. *International Journal of Knowledge-Based Development*, *7*(3), 240-263. https://doi.org/10.1504/IJKBD.2016.078536

Kon, F., & Santana, E. F. Z. (2016). Cidades Inteligentes: Conceitos, plataformas e desafios. *Jornadas de atualização em informática*, 17.3. https://doi.org/10.5753/sbc.6.1

Lazzaretti, K., Sehnem, S., Bencke, F. F., & Machado, H. P. V. (2019). Cidades inteligentes: insights e contribuições das pesquisas brasileiras. *Urbe. Revista Brasileira de Gestão Urbana*, *11*. https://doi.org/10.1590/2175-3369.011.001.e20190118

Lei distrital nº 6.140 de 03 de maio de 2018 (2018). Dispõe sobre estímulos ao desenvolvimento da pesquisa científica e tecnológica e à inovação no ambiente produtivo do Distrito Federal, com fins a estimular a geração de riquezas, e dá outras providências. http://www.sinj.df.gov.br/sinj/Norma/9949d81d0a6e44e190494f3f999610de/Lei_6140_03_05_2018.html

Lei n. 10.257, de 10 de julho de 2001 (2001). Regulamenta os arts. 182 e 183 da Constituição Federal, estabelece diretrizes gerais da política urbana e dá outras providências. Brasília: http://www.planalto.gov.br/ccivil_03/leis/leis_2001/l10257.htm

Lei n. 10.973, de 2 de dezembro de 2004 (2004). Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências. Diário Oficial da União, Brasília. http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm

Lei nº 13.243, de 11 de janeiro de 2016 (2016). Dispõe sobre estímulos ao desenvolvimento científico, à pesquisa, à capacitação científica e tecnológica e à inovação e altera a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 6.815, de 19 de agosto de 1980, a Lei nº 8.666, de 21 de junho de 1993, a Lei nº 12.462, de 4 de agosto de 2011, a Lei nº 8.745, de 9 de dezembro de 1993, a Lei nº 8.958, de 20 de dezembro de 1994, a Lei nº 8.010, de 29 de março de 1990, a Lei nº 8.032, de 12 de abril de 1990, e a Lei nº 12.772, de 28 de dezembro de 2012, nos termos da Emenda Constitucional nº 85,

de 26 de fevereiro de 2015.. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/l13243.htm

Menelau, S., Macedo, F. G. L., Carvalho, P. L. D., Nascimento, T. G., & Carvalho Júnior, A. D. D. (2019). Mapeamento da produção científica da Indústria 4.0 no contexto dos BRICS: reflexões e interfaces. *Cadernos EBAPE. BR*, *17*(4), 1094-1114. https://doi.org/10.1590/1679-395174878

Michelam, L. D., Cortese, T. T. P., Yigitcanlar, T., & Vils, L. (2020). O desenvolvimento urbano baseado no conhecimento como estratégia para promoção de cidades inteligentes e sustentáveis. *Rev. Gest. Ambient. e Sust.- GeAS*, 9 (1), 1-21, e 18740. https://doi.org/10.5585/geas.v9i1.18740

Minghelli, M. (2018). A nova estrutura normativa de ciência, tecnologia e inovação no Brasil. *Encontros Bibli: Revista eletrônica de Biblioteconomia e Ciência da informação*, 143-151. https://doi.org/10.5007/1518-2924.2018v23nespp143

Monfaredzadeh, T., & Krueger, R. (2015). Investigating social factors of sustainability in a smart city. *Procedia Engineering*, *118*, 1112-1118. https://doi.org/10.1016/j.proeng.2015.08.452

Morceiro, P. C. (2019). Nova Classificação de Intensidade Tecnológica da OCDE e a Posição do Brasil. *Setor Externo: Equilíbrio Com Um Ar de Dúvida*, 8. Retrieved from https://downloads.fipe.org.br/publicacoes/bif/bif461.pdf#page=8

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylised facts. *Cities*, *38*, 25-36. https://doi.org/10.1016/j.cities.2013.12.010

Parque Científico e Tecnológico da UnB – PCTec-UnB (2020). *Resolução do Conselho Consultivo do Parque Científico e Tecnológico da Universidade de Brasília Nº 0001/2020*. Recuperado de http://www.pctec.unb.br/documentos/179-documentos/133-regimento

Radziejowska, A., & Sobotka, B. (2021). Analysis of the social aspect of smart cities development for the example of smart sustainable buildings. *Energies*, *14*(14), 4330. https://doi.org/10.3390/en14144330

Rauen, C. V. (2016). O novo marco legal da inovação no Brasil: o que muda na relação ICT-empresa? *Radar: Tecnologia, Produção e Comércio Exterior*, 43, 21-35. Retrieved from http://repositorio.ipea.gov.br/handle/11058/6051

Ribeiro, F. (2020). A física das cidades. *Revista De Morfologia Urbana*, *8*(1), e00159. https://doi.org/10.47235/rmu.v8i1.159

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In *The future internet assembly* (pp. 431-446). Springer, Berlin, Heidelberg. Retrieved from https://library.oapen.org/bitstream/handle/20.500.12657/27702/10.1007_978-3-642-20898-0.pdf?sequence=1#page=423

Secretaria de Ciência, Tecnologia e Inovação (2020). *O que são cidades inteligentes*: Retrieved from https://www.secti.df.gov.br/o-que-sao-cidades-inteligentes/

Silva, A. H., & Fossá, M. I. T. (2015). Análise de conteúdo: exemplo de aplicação da técnica para análise de dados qualitativos. *Qualitas revista eletrônica*, 16(1). Retrieved from https://www.academia.edu/download/56781325/2113-7552-1-PB.pdf

Telles, R. (2001). A efetividade da matriz de amarração de Mazzon nas pesquisas em Administração. *Revista de Administração da Universidade de São Paulo*, *36*(4). Retrieved from http://rausp.usp.br/wp-content/uploads/files/v36n4p64ap72.pdf

Trindade, E. P., Hinnig, M. P. F., Moreira da Costa, E., Marques, J. S., Bastos, R. C., & Yigitcanlar, T. (2017). Sustainable development of smart cities: A systematic review of the literature. *Journal of Open Innovation: Technology, Market, and Complexity*, *3*(3), 11. https://doi.org/10.1186/s40852-017-0063-2

Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N., & Nelson, L. E. (2009). Helping CIOs understand "smart city" initiatives. *Growth*, *17*(2), 1-17. Retrieved from https://www.itworldcanada.com/archive/Themes/Hubs/Brainstorm/forrester_help_cios_smart_city.pdf

Weber, R. P. (1990). *Basic content analysis* (2nd ed). Sage Publications.

Weiss, M. C. (2017). Os desafios à gestão das cidades: uma chamada para a ação em tempos de emergência das cidades inteligentes no Brasil. *Revista de Direito da cidade*, *9*(2), 788-824. https://doi.org/10.12957/rdc.2017.27493

Weiss, M. C., Bernardes, R. C., & Consoni, F. L. (2015). Cidades inteligentes como nova prática para o gerenciamento dos serviços e infraestruturas urbanos: a experiência da cidade de Porto Alegre. *Urbe. Revista Brasileira de Gestão Urbana*, *7*(3), 310-324. https://doi.org/10.1590/2175-3369.007.003.AO01

Weiss, M. C., Bernardes, R. C., & Consoni, F. L. (2017). Cidades inteligentes: casos e perspectivas para as cidades brasileiras. *Revista tecnológica da Fatec americana*, *5*(1), 01-13. Recuperado de http://ric.cps.sp.gov.br/handle/123456789/516