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Analysis of Open Government Data initiatives in Brazil

Cinthya Alcântara Bittencourt

Master of Information Systems for Management

Advisor:

Jacinto Estima

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List of Acronyms

ECLAC	Economic Commission for Latin America and the Caribbean
E-gov	Electronic Government
E-government	Electronic Government
EU	European Union
Gov 1.0	Government 1.0
Gov 2.0	Government 2.0
HDI	Human Development Index
ICT	Information and Communications Technology
ISO	International Organization for Standardization
OAS	Organization of American States
OECD	Organisation for Economic Co-operation and Development
OGD	Open Government Data
OGP	Open Government Partnership
OKF	Open Knowledge Foundation
UN	United Nations

Resumo

O movimento de Dados Abertos tem crescido em todo o mundo ao longo da última década, acompanhando a crescente produção de dados e a evolução tecnológica. Este movimento utiliza as Tecnologias da Informação e Comunicação para fornecer dados de forma disponível, interoperável, com licença livre, reutilizável e acessível a todos. Iniciativas de Dados Abertos aplicadas a dados do governo referem-se a um subconjunto chamado Dados Governamentais Abertos e tem o potencial de apoiar melhores decisões e tornar os governos mais transparentes, eficientes e responsáveis. Entre alguns dos potenciais benefícios identificados estão o impulsionamento do crescimento econômico, o desenvolvimento de inovações, o estímulo às mudanças sociais e à participação cidadã, promovendo, dessa forma, sociedades mais democráticas. O presente estudo identificou requisitos de Dados Abertos encontrados na literatura e caracterizou conjuntos de dados extraídos dos principais portais de Dados Abertos do governo brasileiro em relação à sua conformidade com esses requisitos. Os resultados mostraram que os conjuntos de dados analisados atendem a mais da metade dos requisitos, mas estão longe de apresentar 100% de conformidade. Esses resultados podem apoiar os órgãos governamentais na identificação das lacunas que precisam ser observadas para tornar as iniciativas da Dados Governamentais Abertos mais eficazes e aproveitadas em todo o seu potencial.

Palavras-chave: Dados Abertos, Dados Governamentais Abertos, Democracia, Governo Eletrônico, Transparência.

Abstract

The Open Data movement has been growing worldwide over the last decade following the crescent data production and technological evolution. This movement use Information and Communication Technologies to provide data in an available, interoperable, license-free, reusable and accessible way to everyone. The Open Data applied to government data relates to a subset called Open Government Data and has the potential to support better decisions and make governments more transparent, efficient, and accountable. Among some of the identified benefits that can be reached through Open Government Data are generate economic growth, motivate innovations, trigger social changes, stimulate citizen participation, thus promoting more democratic societies. The present study selected a set of Open Data requirements from the literature and characterized a collection of datasets from the main Brazilian Open Data government portals regarding their compliance with those requirements. The results showed that the analyzed datasets meet more than half of the requirements but are far from being fully compliant. These results can support government bodies in the identification of the gaps that need to be addressed to make Open Government Data initiatives more effective and harnessed to their full potential.

Keywords: Open Data, Open Government Data, Democracy, Electronic Government, Transparency

1. Introduction

The present work is related to the topic of Open Data, particularly the data openness by public governmental entities, known as Open Government Data (OGD).

Data are considered critical elements in several initiatives aimed at supporting global development. Used as evidence, they can allow, for example, the modernization of health systems and the promotion of more sustainable and efficient cities. In addition, it is estimated that the use of large amounts of data in the coming years could generate enormous economic and social benefits. To successfully achieve their full potential, however, public policies and investments geared to data-driven innovations are considered essential [1].

To facilitate the use of available data, the idea of Open Data arises. This concept has been evolving during the last decade, with the first theories emerging in Great Britain. Open Data characterizes the idea of digitally available data for free, for the direct purpose of sharing, without copyright limitations or any proprietary control, so that any user can take advantage of their benefits and republish it according to their interests [2]. Open Data follow the opposite direction of proprietary data, and have almost no usage restrictions, thus increasing and promoting data sharing and reuse. Therefore, this has the potential to encourage the collaboration of various stakeholders and serve as support for innovation and creativity [3]. According to the Open Knowledge Foundation (OKF), Open Data is related to the idea of knowledge openness, enabling any person to participate and make the systems of that the most interoperable as possible. The concept relates "open" to "free", that is, without cost, with an open format for modification and reuse of data, without restrictions such as proprietary data, patents or licenses [4].

The G8 Open Data Charter published in 2013 presented Open Data as a central element of the growing global movement on using technologies, information and social media, but as an unexplored resource. In addition, the potential to promote economic growth, build stronger and interconnected societies, develop more efficient and responsive governments and businesses that meet the needs of citizens was also highlighted. According to the G8, accessing Open Data enables innovation to improve quality of life, services and information sharing internally and with other countries. The

need for access to services and information electronically anytime, anywhere is increasing. Another benefit of Open Data is related to the increase of transparency, accountability, and consequent public management awareness. Although they collect large amounts of data, governments do not always make them available, which is a missed opportunity [5].

Over around 2009, data portals developed by the United States and Great Britain were the first initiatives taking place. Following them, other countries around the world have been adopting similar strategies within the public sector, as a form of transparency for public revenues and expenditures. The tendency was to use legal mechanisms to compel public sectors disclosing information about fiscal data [2]. The availability of data provided by governments is based on values such as transparency, collaboration and citizen participation, which are enabled by making data accessible in an open and accessible way, leading to the development of innovative solutions [6].

Public entities, as vast data generators, can use Open Data initiatives to add value to the management of public resources. OGD can promote greater transparency and stimulate the re-use of data by internal and external actors, stimulating a higher efficiency of public services and improving the life quality of society [3]. These initiatives can also be the basis of a new type of public governance, strengthening democracy through collaborative action, transparency and economic development [7].

Despite the estimated Open Data movement potential, there is still limited evidence of its effectiveness mainly due to the limited use of the respective data. This limitation occurs for different reasons, such as the lack of public incentives, the low number of people with the necessary technical skills, and low awareness of its relevance by the citizens [6].

1.1. Context

The concept of Open Data started in Britain, advancing in 2009 with the launch of the first Open Data portals in Britain and the USA. As a result, many countries around the world began to make their data openly available using what is nowadays known as open portals over the Internet, as a means of sharing data and expecting at the same time that

knowledge would be generated. The initial tendency was to use legal mechanisms to compel the public sector to disclose information about fiscal data [2].

The availability of data made by governments is based on values such as transparency, collaboration and citizen participation, and the idea that by making data available in an open and accessible way could lead to innovation [6].

There are several understandings about the meaning of Open Data. The most common is the one that presents Open Data as heterogeneous data coming from different sources, that must be made available without restrictions of copyrights, controls or patents. Therefore, it is understood that data are made available in a free and easily accessible, in a way that enables machine-readable, reuse and redistribution free of charge. Besides presenting various interpretations, the movement is in a continuous process, causing new sources of study to emerge [8]. Open Data initiatives have shown the relevance of government data to society, since anyone can access, reuse or share data for any purpose. Several studies indicated that in the long run they can have a positive impact on the economy [9].

In addition to government data, citizens can also generate Open Data which are openly available for public domain use. These data can also be the basis of a new type of public governance, with the potential to strengthen democracy through collaborative action, transparency and economic development. However, there are still few studies showing the relationship of such data and the resolution of public problems [7].

An important issue to consider is related to the quality of publicly available data. To exemplify, in 2012 in Great Britain, a qualitative method of re-evaluating the datasets made available in a 5-star classification scheme was introduced in the following sequence: 1) one star for data available on the web in any format; 2) two stars for structured data; 3) three stars for data in open and non-proprietary format; 4) four stars for data that follow open standards and recommendations from the World Wide Web Consortium (W3C); 5) five stars for data linked to data from other sources in order to provide content. Other forms of qualitative data evaluation have already been proposed, but all have in common the re-use of data, the non-proprietary format, standardization and free access [2].

The Open Data movement has grown considerably in recent years, mainly because of the potential opportunities it can offer, such as increased information sharing and

transparency, economic growth, social change, innovation and the development of a change in the culture of government management, with new forms of accountability [10]. Therefore, Open Data initiatives have the potential of economic, political and social added value, depending on their implementation [11]. The practical effectiveness of such potential, however, is still little known [10]. Despite the potential considered, there is still limited evidence of the effectiveness of the Open Data movement, mainly because of the limited use of data. The lack of incentives, technical skills and aware about their relevance are part of the reason for sparse use of data [6].

1.2. Motivation

The motivation for this research is directly related to the necessity of verify the existing gaps between claimed Open Data initiatives, more particularly government data, and the necessary requirements for it to be in fact considered open. Finding the obstacles that impede the effectiveness of Open Data, can be an instrument for improving and reaching the benefits of these actions.

The Open Data movement has recently evolved worldwide, with successes achieved from these initiatives. Millions of government datasets have been opened to the public through of legal mechanisms in several countries. Organizations, professionals and researchers have been dedicated to the development of this area. In addition, the benefits of Open Data are demonstrated in an increasing number of scientific publications and research projects. Despite that, there are still challenges that must be overcome so that all their potential estimated can be reached. [12].

Government data are considered valuable and strategic assets. Manage them effectively, making them openly accessible and reusable has the potential to strengthen democracy, improve quality of life, boost government efficiency, allowing to measure and analyze public policies, create new economic and generate innovation [13], [14].

The literature points out that the process of government data openness presents some challenges. Among them are: lack of culture and skills in organizations; privacy legal issues; technical support infrastructure, as well as the economic resources needed to publish the data. From the perspective of the user, the challenges range from the lack of

technical skills for data manipulation to the lack of knowledge about the existence of such public data. In addition, data quality, related to integrity and accuracy is another issue. Consequently, these issues together result in barriers to the re-use of data [6].

1.3. Problem Definition

The literature identifies gaps between theory and practice, i.e., there are differences between what are the requirements, and what governments claim they are doing [15]. The extraction of information and knowledge from several sources of heterogeneous data has been a challenge for most of the actions researched. Therefore, it may have untapped potential in supporting problem solving and decision making, e.g. greater efficiency of government actions, citizen engagement in public decision making, and economic growth [16].

Many of these initiatives have demonstrated that governments are evolving in the perception of the Open Data movement when they make their data available, but do not invest efficiently in initiatives with a broader access and innovation. In some cases, features such as open standards, non-proprietary formats, among others, are not available [11].

Therefore, it is important to compare datasets made available by governments through OGD initiatives and try to understand if they really follow the main requirements to be claimed as such.

1.4. Objectives

The current work is focused on characterizing Open Data initiatives in Brazil. This characterization was carried out over different portals from different public entities. This allows interested entities to identify possible aspects that can be improved, so that the potential benefits of Open Data can be better realized.

This main objective can be decomposed into the following specific objectives:

1. Characterize Open Data initiatives in these portals, based on requirements defined for Open Data from different authors;
2. Identify the gaps found in the datasets available between the characterization and the requirements to be considered Open Data.;
3. Demonstrate, through tables and visualizations, specific points of gaps so that the datasets are compliant with the defined requirements.

2. State of The Art

Open Data relates to data that must be non-proprietary, machine-readable, interoperable, open-format, access free, unrestricted and reusable by any stakeholder [3], [17], [18]. There are several areas related to Open Data applications. In this section, some of these areas were explored to show the relevance of Open Data in sectors that have been increasingly using it over the last years. However, the main objective of this work is to characterize initiatives of OGD, which is nothing more than the use of Open Data applied to the government data openness [16].

The first steps in sharing government data openly came from the concepts of Transparency and Accountability. This is because in recent years citizens have become increasingly interested in the way how governments make use of public resources. Therefore, as a way of opening the government management to society, one of the options to achieve these objectives is through Open Data initiatives [3], [17].

The literature shows global Open Government Data applications taking place from joint initiatives among countries. Based on agreements between these countries, organizations were created to promote the government data openness and they are the key drivers of the various OGD initiatives around the world. They are entities that work to define and guide the objectives and actions for the effective implementation of these initiatives. Examples of these are the Open Government Partnership (OGP) in 2011 [18]; the G8 Open Data Charter in 2013 [5]; and the Open Data Directive of 2019 [19] replacing the Public Sector Information Directive 2003 of the European Union [20].

2.1. Open Government Data, related concepts, goals and potential impacts

Initially, it is important to understand that Open Government Data is contained within the Open Data concept. As previously discussed, OGD is the Open Data applied to government data [16]. That is, it is the government data openness through innovative technologies and information technology platforms that allow their access and exploitation [21]. Moreover, the simple government data openness does not make it Open Government (OG). Often Open Data initiatives are cited as the solution for problems such as corruption, lack of citizen participation and inefficiency in the management of public

resources. However, despite their importance as a driver of cultural, political and economic changes, the simple data openness does not have this effectiveness. Public policies associated with Open Data initiatives need to be implemented to truly reach their transformation potential. In that sense, Open Data is just one of the principles to achieve the Open Government goals [22].

Another concept related with OGP is the Electronic Government (e-government or e-gov). A diversity of definitions for e-government were found in the literature. Initially, e-government emerged as the government's simple online presence. It is related to the use of technologies, usually online applications, to improve public services. However, this concept has evolved, especially with the introduction of the Open Government concept, and Open Government Data initiatives have come to be considered as an extension or subset of Electronic Government [16]. In a different approach, e-gov is characterized as a reinvention of government, particularly when governments use ICT in innovative ways to provide citizens and enterprises with a more convenient access to higher quality and lower cost government services and information through the internet. In addition to bring government and citizens together, this strategy allows a greater participation of citizens in the democratic process [23]. In another research, e-government was also named e-governance for government informatization associated with the potential of implementing best governance practices through increased transparency, corruption reduction, citizen empowerment, and improved government finances [24].

Government 1.0 (Gov 1.0) and Government 2.0 (Gov 2.0) are also terminologies that were addressed in the literature as a modernization of the public sector from the perspective of e-government. This happened based on the advances of ICT associated with changes in relations between governments and citizens. Initially, e-government appeared as a passive presence on the internet by simply digitizing government information. Subsequently, this concept evolved from interactions between government, business and citizens through forms and emails, providing online services such as tax payments; until reaching the idea of shared governance, with a change in the govern way and make decisions based on the bidirectional exchange of information. In other words, from a government that is an information provider, named Government 1.0; until the emergence of the concept of Open Government and Government 2.0, which provides but

also receives information and dialogues with citizens, fostering a collaborative and participatory governance model [25].

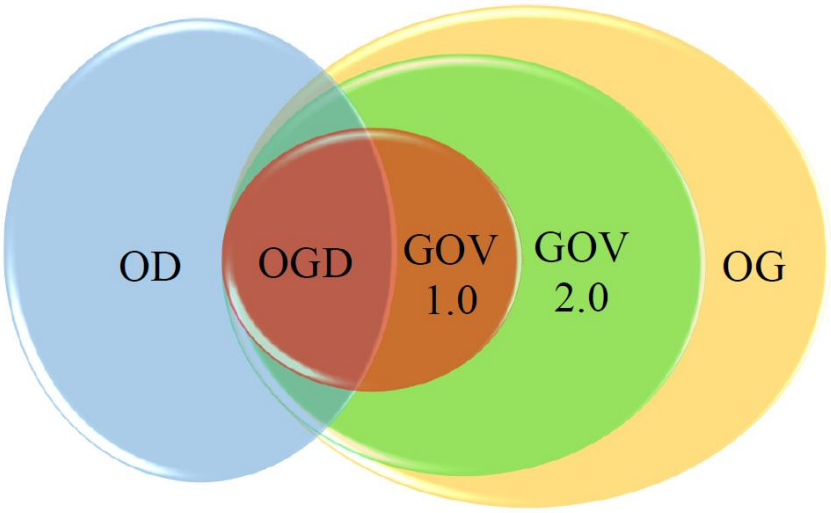

Figure 1 - Venn Diagram with Relationships between Concepts Related to OGD (developed by the author)

Figure 1 presents the concepts that were investigated and the relationships between them. Although these concepts are still controversial in the literature, for this study the relationships were considered as discussed. Briefly, OGD initiatives can be present in all concepts. They can be classified as one of the Open Data application forms, as well as a means to achieve Open Government objectives and one of the Gov 1.0 and Gov 2.0 implementation ways. Importantly, while the focus of Gov 1.0 is the use of technologies that allow the presence of government on the internet, the main objective of Open Government is citizen participation. In other words, while Gov 1.0 has the potential to allow such participation, the mere presence of government on the internet already characterizes Gov 1.0, but it is not enough to characterize Open Government. Finally, although the concept of Gov 2.0 has emerged from the concept of Open Government, they are not the same. The concept of Open Government is broader and a new concept of government. It has a focus on a new governance model, based on promoting citizen participation and collaboration. In that sense, this new concept can improve democracy practices in the society. On the other hand, the concept of Gov 2.0 is an evolution of Gov 1.0, that takes advantages of a broader range of new technologies applied by governs.

To provide an Open Data Guide, the OKF produced The Open Data Handbook. Despite presenting a guide to defining Open Data, the introduction addresses information

about OGD, which details the definition of Open Data particularly in relation to governments. In this section, the guide refers the understanding of government's use of public resources and highlights the importance of new technologies that can automatically answer social questions. It also explains that many social development solutions can be found through data that are generated by public entities. From this, it emphasizes the importance of Open Data to unlock these data and make it available to everyone through easy access and using formats that make it usable. Finally, it indicates the potentially positive impact of Open Data on improving the quality of life of citizens and the government and society functions [26].

Table 1 - List with researched organizations and related sources.

Organization	**Source**
G8	Open Data Charter and Technical Annex [5]
OGP	Open Government Declaration [27]
OECD	Digital Government - Open Government Data [28]
EU	Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information [19]
OKF	The Open Data Handbook [26]
OAS	The OAS Fellowship on Open Government in the Americas [29]
ECLAC - UN	Open Government [30]

Among the international organizations driving the global OGD movement, Table 1 lists those that were analyzed to identify how they are associated. The first point to note is that they all support the use of technologies that enable the openness of governmental data and improve the flow of information within and between countries, as a means to achieve social goals in order to improve governance and quality of life. This movement is presented with the potential for the development of stronger and interconnected societies capable of meeting citizens' needs and enabling innovation and prosperity. Leaving aside the peculiarities of each organization, we identified the main motivations for OGD initiatives listed as follows:

1. Transparency
2. Accountability
3. Innovation

4. Government Efficiency
5. Improved Governance
6. New Business
7. Economic Growth
8. Universal accessibility to public information
9. Citizen Participation and Collaboration in Government
10. Empowerment of citizens
11. Greater democracy
12. Fighting corruption
13. Freedom of Expression
14. Development and Improvement of Citizen Services
15. Interoperability

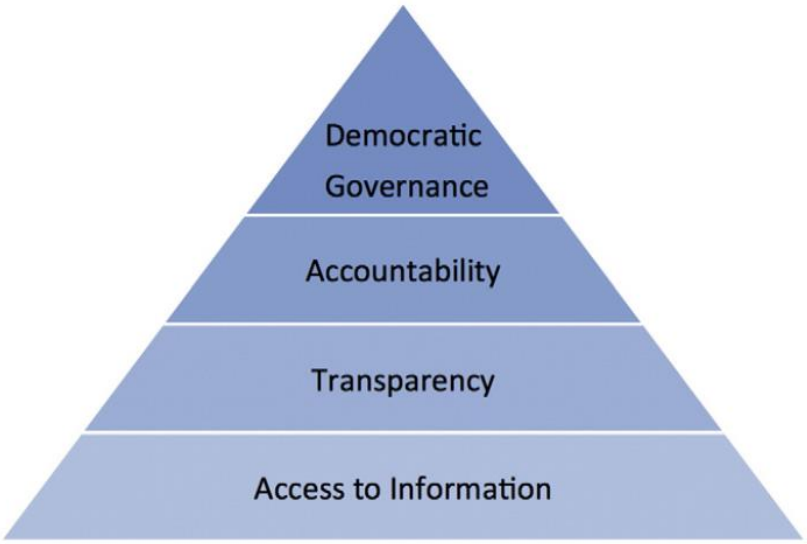

Figure 2 - Relationship between different impacts of OGD [16]

In the paper "A systematic review of open government data initiatives" [16], the concepts of transparency, citizen participation and collaboration used to strengthen democracy, were considered as the three pillars of government dataset publishing, with the potential to promote greater accountability, combat corruption and affect multiple stakeholders in different ways. Through the analysis of different discussions found in the literature, the authors readapted and demonstrated different levels of OGD impacts as shown in Figure 2. In summary, they describe that each impact is built upon or supports another impact. It is not a dependency relation, but a relationship in which each one

supports the next, increasing the level of impact. For example, the first and most direct impact of data openness is the access to information. By allowing access to relevant information, OGD initiatives can make governments more transparent. And if government is more transparent, citizen participation in government and social control over public management may increase, which raises the level of accountability of the public managers. From this, it is possible to intensify the deepening of democracy, in which better informed citizens are able to collaborate with public decisions, making them more efficient and effective. The result is a governance that is more focused on the needs of citizens.

2.2. Using Open Data in Smart Cities

The conceptual approaches of Smart Cities are diverse. However, to exemplify the application of Open Data, a comprehensive concept found in the literature will be used. Smart Cities are initiatives that use technology to improve the lives of individuals in urban spaces. They are presented as an infrastructure based on data processing and whose main objectives are promote a more efficient governance, improve the quality of life, develop greater sustainability of the environment and offer better opportunities for the growth of companies [31]. In addition, one of the frequently cited aspects in the literature is the use of Information and Communications Technology (ICT) as an instrument for better management of Smart Cities. ICT is a key factor for the effective implementation of the Intelligent Cities initiatives [32]. To conclude, it is possible to identify that this concept has evolved as a way to solve urban issues and promote sustainability in urban planning [33].

To achieve the objectives of Smart Cities, the Open Data are pointed out as a way of promote greater government transparency, reduce public spending, increase the efficiency of government actions, and stimulate the economy through innovation. [31]. Other research has concluded that managing large amounts of data is essential to support new solutions in Smart Cities. Using relevant data is presented with an essential aspect of society. Open Data can be a source of essential information for the development of this new society as a way to improve the lives of all individuals. This is because data are sources of information, so they are resources that feed the new knowledge society [34].

Like Open Data, Smart City initiatives multiply around the world. A research was conducted in Barcelona, Manchester, Helsinki, Chicago and Amsterdam, specifically to investigate the convergence between Smart Cities and Open Data. Openly discussing data has been an essential aspect of making cities work better. An example is the predictive analyzes made possible by the data. The research has resulted in areas where Open Data has an impact on the Smart Cities, which are: Environment, Economy, Tourism, Education, Transportation, Energy and Governance. The main standard found in this convergence was innovation in an open way, that is, Open Data provides support for innovation in Smart Cities [35].

The convergence between the availability of urban data in an open way and the use of digital technologies supports this sustainability, which is a key factor in the concept of smart cities. Open Data is also cited as a resource for innovations, economic and social benefits. And in the context of citizens, it is stated that access to Open Data stimulates an environment in which they can access issues that allow the goals of intelligent governance solutions to be achieved [33].

In summary, it can be inferred that Open Data are valuable resources used in Smart Cities implementations. This new vision of cities is spreading all over the world, leveraging technology to develop a more sustainable environment, with more efficient governments and a better quality of life for citizens. Therefore, they are assets that support this vision of the future and must be increasingly exploited and their use increasingly improved.

2.3. Open Data Initiatives Around the World

Over the last years, researches have been conducted to highlight OGD initiatives around the world. The literature review on these initiatives provided information about different ways of Open Data application, motivations, implementation challenges and social impacts.

In 2015, a study [9] investigated policy goals achieved through Open Data provided by the city of Amsterdam. According to the authors, the Open Data movement brings attention to the potential social value of government data. In this case, the motivation was

the possibility of economic growth, government efficiency and transparency, despite the lack of a strategy to prove the achievement of these objectives. The value of new services, products and jobs generated through Open Data was estimated between 3 to 200 billion euros for the EU. Initially as experiments to drive the use of Open Data, a digital platform was developed, and application contests were held. The result was the availability of 326 datasets for use and reuse, and 70 applications that showed how government data can be presented and used. In addition, these apps contribute to the economy by driving new business models, improving access to the city through transportation information, and promoting the city by providing information which generates public interest and promote tourism. From the perspective of internal efficiency, Open Data has been integrated into government, and contributes to innovations such as online services, cost reduction, and the prevention of fraud, waste and bad investment decisions. Finally, about transparency, the contribution was publicizing policies and government progress. One challenge encountered was citizen's misinformation about these initiatives, with low app downloads and few visits to online resources. Nevertheless, it was observed that when people are aware of the availability of data, they become interested. An example of this was the result of 5% of citizens that visited the Stadstat (a website that showed progress on political actions in the city of Amsterdam), increasing to 43% after raising awareness about it.

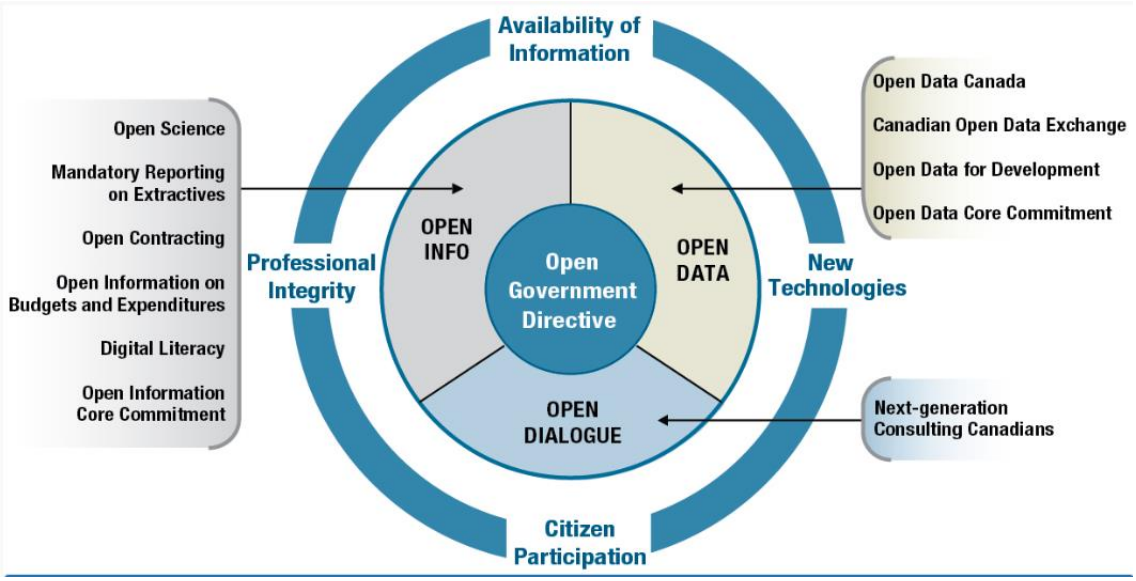

Figure 3 - Canada's government commitments with Open Government [36]

In 2017 a paper [11] was published that investigated Open Data portals, focusing on British Columbia - Canada, to verify the design related to data access and usability limitations. Some bases for this research were based in Canadian government documents

related to Open Data implementation. In "Canada's Action Plan on Open Government 2014-16" [36], the Canadian government points to its commitment to "ensure portals are easy to use, data is easy to discover and datasets are readable for all individuals, not just those with an extremely high level of data literacy ". Extracted from this document, Figure 3 shows the Government of Canada's commitments to drive Open Data implementation. Associating these commitments with research [11], the authors argued that access to data can be improved by including usability measures. According to them, website design does not provide tools or sufficient information to access and use the data. They also pointed out the following improvements that can be made to portal design: a) increased portal visibility, for example, from direct links: streamlines and facilitates site findability; b) provision of integrated search capabilities: enables search across many different datasets. c) increased metadata presence and specification to allow datasets to be localized even when users do not know the exact label, (i.e., provide clear identification of content and dataset updating, which increases the usability potential of Open Data). The main conclusion of this investigation was that significant improvements can be made to achieve the Open Data related inclusive access goals. The authors recommended that usability testing should be performed on other Open Data portals to demonstrate the relevance of citizen access and use, as well as benefiting the field of Open Data research.

In 2018, a research [37] investigated the use of Open Data provided by local governments in Japan with de goal of improving the urban planning process. In a previous research, the authors concluded that the data were not used sufficiently or effectively shared with citizens. To better communicate between government and citizens, researchers have developed the MyCityForecast tool, an Open Data digital portal (https://mycityforecast.net/), which features a dashboard with an urban simulation system. It simulates future cities from current statistics on urban and population data. Through data integration, it was possible to simulate how the cities will be until 2040. This simulation provides two views, one with the current planning type and the other one with a new kind of planning, that was named by the authors as compact city. In the compact cities, the public facilities (e.g. hospitals, schools, etc.) would be implemented in places that facilitate access by the population. Also, the citizens would be living in a residential area near these facilities in order to improve the accessibility and efficiency of public resources. With this research, it was important to understand the relevance of the data to make forecasts and use them in urban management processes. In addition, it has been

shown that to implement this type of planning, population awareness is needed in order to stimulate cooperation and participation. Data, technology and cooperation between governments and citizens have the potential to solve problems and improve the quality of life, in a more efficient and sustainable environment [37].

Also in 2018, a paper [38] was published about the results of Open Data initiatives in US cities that were considered among the first in the world to invest in the Open Data movement from Open Government Data portals that provide machine-readable public data. Although the main result was the increased transparency, the article analyzed the innovation results derived from the use of Open Data. This article also indicated that there are still few studies on the actual results and impacts of open innovation data. In addition to the data dissemination policies, the Open Government process also includes public participation in the movement, as a way to stimulate the re-use of Open Data in a relevant way. Innovating with Open Data can have several meanings, both for the government internally, and for citizens and businesses, externally. It could mean the creation of new products, the improvement of services improvement, or the creation of new business or new applications. So, there are new ways of reusing data. Internally, it can mean efficiency, improved performance of services provided to the public or work processes. Externally, it can mean new products or new forms of relationships with external stakeholders, such as customers or suppliers. In this way, the openness of data offers a new way of addressing and solving social challenges, with innovative solutions to existing problems. With data openness, external parties can collaborate to solve these problems, provide new insights, and better understand the needs of various stakeholders. Through this new form of management, it is possible to perceive that the public administration evolved from a closed culture, to an open and collaborative structure. From that, provides and discloses the way resources are being used. This openness allows better monitoring by the interested parties, improvement of efficiency through data-based decision making, and increase accountability of resource managers. Although the research has not presented results that can be generalized, there have been some important conclusions, such as the need to understand what cultural and structural changes are necessary, the applications are the main tools to achieve external innovation results, to hold local governments responsible for encouraging the innovation, the need to make public officials aware of changes in work routines. It has been concluded that Open Data initiatives can generate an increased real pubic value increases as they lead to innovation

approaches, which can improve public management performance, efficiency and decision-making, as well as improving performance, credibility and confidence in the use of resources and citizen participation. For this citizen engagement, the authors pointed out that through marketing, competitions and contests awarded, this engagement could be improved [38].

2.4. Open Government Data in Brazil

In the case of Brazil, as in other countries, OGD initiatives started from legal norms. According to the Constitution of the Federative Republic of Brazil, the main legal instrument of the country, the Brazilian territory covers the public entities named Union, States, Federal District and Municipalities [39]. There are Open Data initiatives from each of these entities. Moreover, there are also datasets from some of these entities centralized in the Brazilian Open Data portal [40].

In 2011, Brazil, together with Indonesia, Mexico, Norway, the Philippines, South Africa, the United Kingdom and the USA, founded the OGP to disseminate Open Data initiatives in their countries. The goal was that by investing in technologies to create and encourage openness, they would contribute to: 1) promote more open, effective, transparent, reliable and accountable governments, and 2) connect governments with citizens more easily. [17].

To achieve these objectives the OGP has established the Open Government Declaration that has been endorsed by 75 OGP participating countries. This document establishes the principles with which countries must commit themselves for the promotion of a socially participatory, transparent and open government. An eligible country wishing to join OGP should endorse the Declaration in its Letter of Intent [18].

INDA is the National Open Data Infrastructure, the mechanism of the Brazilian government to guide Open Data initiatives, and to concretize the commitment with OGP [41]. This occurs by establishing technical standards, in order to make this data available in a standard format and readable by machine, in addition to providing training and stimulating this opening of data by the government [42].

In Brazil, there are two main Open Data portals: the Transparency Portal (http://www.portaltransparencia.gov.br) [43] and the Brazilian Open Data Portal (http://dados.gov.br/) [40]. The difference between these two portals is specified in the Brazilian Open Data Portal "FAQ" section. There it is declared that the first one provides fiscal, budgetary and financial information of the various Brazilian Public Entities, as a form of control of government revenues and expenditures. On the other hand, the Open Data portal is presented as a central point of reference for Brazilian public data on any subject, aiming to standardize the access, reuse and implementation of technologies [40].

The Transparency Portal, created with the objective of increasing fiscal transparency and stimulating citizen participation, was considered one of the most critical initiatives related to the control of public spending and recognized as a model of best practices in 2008, by the United Nations Convention, against corruption and in 2009 at the third European meeting on anticorruption in Brussels [43].

In a research carried out on the Transparency Portal as a data entry tool in Brazil, it was observed that it contributed to reveal irresponsible or illegal public spending. This, in turn, has led to the engagement of citizens in the supervision of public accounts and involvement in anti-corruption campaigns, since they have been able to access and perceive the mismanagement of public resources, which has generated social revolt. On the other hand, some challenges have been identified, such as how to make data useful, considering aspects such as availability and technological understanding, and the need to address privacy issues (e.g., to anonymize data that may identify individuals [42]. History was made on the process of data publication in Brazil with the main moments as follows [42]:

- The Brazilian Federal Constitution of 1988 established the need for advertising administrative action data as one of the five principles of Public Administration;
- In 2000, the Fiscal Responsibility Law, which established standards for responsibility in fiscal management, determined the public disclosure of essential budget documents;
- In 2004, the creation of the Transparency Portal, by the Federal Comptroller General's Office in partnership with the Federal Data Processing Service;
- The Law on Access to Information, implemented in 2011, regulated citizens' access to public documents, according to the constitutional provision;

- In 2012, the Brazilian Open Data Portal was launched as a tool for data availability and public consultation;

In a research published in 2014, the city of Rio de Janeiro was used as an example of integration and centralization of public data from different governmental organizations. The Operations Center of the City Hall of Rio was presented, with the centralization of data from 30 public agencies, in order to unify the access to data from areas such as emergency services, public transportation and traffic, which would facilitate the work of public agents. However, the study indicates that this centralization was done in partnership with IBM, generating problems related to the lack of control over data, privacy issues, proprietary software, among others. These issues can impact the requirements for data to be considered as Open Data [44].

In 2016, another study related the characteristics of different Brazilian Open Data portals. This study indicated that several Brazilian entities have submitted attempts of Open Government Data initiatives but concluded that many of the published data do not meet the requirements to be considered as Open Data. For example, proprietary data or the lack of specification on open license were found [45].

Also in 2016, a research [46] conducted on the capital of main brazilian states, São Paulo, Rio de Janeiro, Curitiba, Recife and Porto Alegre, revealed informations about their official Open Data portals and other websites with Open Data initiatives. The study pointed out that the municipalities with the highest level of transparency are not those with the best Open Data initiatives. That is, greater transparency, in the sense of mere availability of data, did not directly mean government actions to promote digital democracy. To exemplify the results found in this study, São Paulo and Curitiba, which had the largest amounts of dataset available, presented problems regarding data quality, such as proprietary formats or outdated information in a systematic way. On the other hand, Recife presented less data, but with higher quality, being continuously updated and providing non-proprietary data, besides the development of applications with focus on citizens. Another problem was the dispersion of information through different portals without links between them. For example, in Rio de Janeiro, where the Transparency Portal has no link in the municipal government's home page, which makes it difficult to locate information. The conclusion was that to promote Open Data initiatives it is not enough to make data available, it is necessary to promote ways to facilitate their access,

the process of locating information, by using non-proprietary data formats, machine-readable and ensuring their continuously updated [46].

3. Methodology

This work started by consolidating a list of requirements transversal to the multitude of Open Data and Open Government Data definitions and concepts found in the literature. After that, datasets that could provide useful information were selected from the main Brazilian Open Data portals and investigated in two case studies. These datasets were characterized by defining a degree of compliance with the defined set of requirements.

In the final analysis besides the qualitative methodology analysis of the datasets, a quantitative analysis was also performed. This quantitative analysis demonstrated the compliance percentage of the datasets with the Open Data requirements, as well as the percentage of indicators for which related datasets were found in the portals.

3.1. Open Data Requirements

The most frequent definition of Open Data found in the literature is based on the Open Knowledge Foundation. According to OKF, to be considered Open, the initiative must allow the data to be used, reused, shared and redistributed by anyone. Data must therefore be available in a modifiable and machine-readable format. Preferably, these data should be available in an open format, with the possibility of downloading via internet without costs. On the re-use and redistribution, it should be possible for such data to be integrated with other data, that is, data should have the maximum possible interoperability. And, finally, access must be universal, with free license of ownership, without any discrimination or restriction [4].

In the Open Data Handbook produced by OKF it is possible to understand the characterization and importance of the interoperability for Open Data. Interoperability is characterized as the ability of different organizations and systems to work together from different data sets. With the sheer quantity and complexity of data sets available, communication between them is critical. That is the reason why interoperability is essential for Open Data to be truly harnessed to its full potential. Opening code and allowing open access and use can make it possible to combine the various datasets and thereby develop new products and better services. The clear definition of Open Data, with this interoperability perspective, is that it can prevent large amounts of data from being

available, but with little or no ability to integrate it into larger systems, which is its true value [26].

On the other hand, there are other criteria specifically applied to the Open Government, that is, Open Data applied to the free availability of government data. The Organization for Economic Co-operation and Development (OECD) defines OGD as a philosophy and set of policies that must be followed to make government data available openly, stimulating transparency and improving accountability. The OECD says that with such openness and transparency, public services can be improved, governments can be held accountable for their actions, and citizens will be able to monitor and levy public actions. Moreover, since public bodies produce large amounts of data, private institutions can use it to generate innovation that bring benefits for citizens [28].

The Open Data Charter signed by the leaders of the G8 countries in 2013 establishes the importance of Open Data for the promotion of transparency and innovation and affirms the commitment of each nation with a set of principles related to Open Data, which, in summary, determine the following: 1) all data that does not have advertising limitations must be opened by default in open and machine readable formats; 2) OGD must be of high quantity and quality, controlled and cleaned; 3) such data must be standardized from their metadata (e.g. the description of the published data) and have open licenses that guarantee universal access, so that they can be used by everyone; 4) certain datasets that are specified in the Charter, as well as information from civil society, should be open and internationally shared to encourage better governance practices; 5) High-value defined datasets must be opened, with the developer involvement and startups financing the use of Open Data, to stimulate innovation [1].

Brazil, together with other countries around the world, have declared a commitment to promote the openness of government [18]. This statement was made in the context of the joint creation of OGP, and establishes a list of commitments gathered in the Open Government Declaration, which was published in 2011 and endorsed by 75 participating countries, in order to promote a global open government culture and participatory with trained citizens. The Declaration begins by affirming the convergence of commitments with the principles of the Universal Declaration of Human Rights, the United Nations Convention against Corruption and other applicable international instruments related to human rights and good governance. It then reinforces the objectives of transparency,

accountability, fight corruption, citizen participation, human dignity, citizens' well-being and the promotion of technological innovations geared towards more efficient governance and an increasingly interconnected world. Finally, the commitments are listed and specified, indicating ways to achieve the planned objectives. Briefly, the commitments are as follows [27]:

1. **Increasing the availability of information about governmental activities**: encouraging the collection and publication of data on public service expenditures and their quality; promoting the access to information and the publicity of government actions; providing understandable and timely data with open standards formats to facilitate interoperability, easily localizable and reusable; and, finally, valuing citizens' feedback in order to provide data that is valuable and of interest to them;
2. **Supporting civic participation**: creating mechanisms for interaction between governments, citizens and companies; and encouraging participation and popular engagement, without discrimination, in the formulation, monitoring and evaluation of public decisions and policies;
3. **Implementing the highest standards of professional integrity throughout our administrations**: combating corruption through measures to prevent bribery and transparency of public finances and expenditures; and implementating and improving ethical standards for public officials;
4. **Increasing access to new technologies for openness and accountability**: using new technologies that allow information sharing, citizen involvement and understanding of public actions; encouraging civil and business involvement as ways of identifying innovative practices and driving new technologies; and supporting the capacity of governments and citizens to use these new technologies.

In a research that defined the differences between Open Data and Open Government Data, it was stated that the simple data openness is not enough to promote Open Government. Although they consider the importance of Open Data for economic, cultural and political changes, the study emphasizes that other policies are necessary for the effectiveness and evidence of this transformative potential. The authors have created the Table 2 with the proposed principles for Open Government [22]. This table is used by the OGP, which highlights the relevance of the proposed principles [47].

Table 2 - Proposed Principles for Open Government [47]

Principle	Description
1.Effective participation	Participation is encouraged and includes informing, consulting, involving and empowering citizens and social organizations.
2. Transparency and accountability	Governments must actively account for all their actions and take public responsibility for their actions and decisions.
3. Open Data	Open, complete, primary, timely, accessible, machine processable, non-discriminatory, non-proprietary, license-free data must be made available and in accordance with international standards for publishing data on the Web.
4. Opening and reusing public information	Public information must circulate to reach its full potential. Priority is given to the use of license-free, allowing the reuse of information.
5. Access and simplicity	Whenever possible, simple and easy-to-understand language is used.
6. Collaboration and co-creation.	Practices and policies are designed to encourage collaboration and co-creation at all stages of the process.
7. Inclusion and diversity	There is attention to diversity and inclusion. Women, the disabled, minorities and / or vulnerable are included. Attention includes the use of appropriate languages, technologies and methodologies to include minorities.

The OECD, which is OGP's partner in Open Government actions, indicates that the importance of Open Government increases as people around the world are more interested in the openness of the government. Citizens want increased transparency and accountability over public actions. These actions must be in accordance with social needs. The openness of government data allows for a change in the interaction between rulers and citizens. In addition, there is a growing recognition of the relevance of open government for greater inclusiveness, democracy and advances in governance. According to the OECD, the principles guiding these initiatives are integrity, transparency,

accountability and stakeholder participation. This organization supports the culture of government openness based on advice and recommendations. In 2017, the OECD Governing Council's recommendation described a set of key principles, which are summarized as follows [48]:

1. **Transparency**: disclosure and accessibility of relevant government data;
2. **Integrity**: prioritization of the public interest over the private;
3. **Accountability**: accountability of government officials for actions, decisions and performance of public activities.
4. **Stakeholder participation**: involvement of all persons included in public activities.

After the investigation of the literature, the selected requirements were described to specify how the analysis of compliance degree was performed. Identifiers (Ids) were used to facilitate the development and visualization of the resulting Tables. Each Id in the Results is related to a requirement or dataset. The Table 3 lists the requirements, descriptions and related ids which was used in the Results Tables of the Case Studies to characterize the datasets available in the main Brazilian Open Data Portals. In the description, there is the definition that were used to evaluate the compliance of the datasets according to the requirements. In order to demonstrate Open Government Data's support for Open Government, the "Open Government Features" column has been added, which presents the principles found in the literature that are considered essential to Open Government.

Table 3 - List of Requirements and related Ids that will be used in the Result Tables

Id - Requirement	Description Considered in the analyzes	Open Government Features
A - Complete	All public data that is not subject to legal issues about privacy, security or access privilege requirements, must be available [8]. Available as a whole [4].	Transparency [47]
B - Primary	Data should be published as collected at the source, with the maximum	Accountability [47]

	granularity, and without aggregations or modifications [8].	
C - Timely	Available in the minimum time necessary so that there is no loss of value [8].	Opening and reusing public information [47]
D - Accessible	Available to all variety of users and possible purposes [8] Possibility of downloading via internet without costs [4].	Access and simplicity [47].
E - Machine Processable	Data that can be automated [8]. Available in a convenient and modifiable form [4]. Machine-readable format: must be provided in a form readily processable by a computer and where the individual elements of the work can be easily accessed and modified [4].	Increase access to new technologies for openness and accountability [27].
F - Non-Discriminatory	Accessible without registration for any person [8]. Access must be universal; everyone must be able to use, reuse and redistribute. should be no discrimination against fields of endeavor or against persons or groups [4].	Inclusion and diversity [47].
G - Non-proprietary	Available in a format that does not have any exclusive control [8].	Collaboration and co-creation [47].
H - License-Free	Free of patents, trademarks, trade secrets or copyrights [8]. Public domain or provided under an open license [4].	Opening and reusing public information [47].

3.2. Methodology of Case Study 1

In the first Case Study an analysis was made over datasets from the Brazilian Union (national data); the Federal District; the states of Alagoas, Espírito Santo, Pernambuco, Rio Grande do Sul and São Paulo; and the municipalities of Fortaleza, Recife, Rio de Janeiro and São Paulo. Table 4 lists the links to Open Data Portals selected in this first stage of characterization by Type and Region. All the portals listed had their last access on February 5, 2019.

Table 4 - List of Links to Open Data Portals by Type and Region

Type	**Region**	**Link**
National	Union	http://dados.gov.br/
Capital	Federal District	http://www.dados.df.gov.br/
State	Alagoas	http://dados.al.gov.br/
	Espírito Santo	https://transparencia.es.gov.br/DadosAbertos
	Pernambuco	http://www.dadosabertos.pe.gov.br/
	Rio Grande do Sul	https://dados.rs.gov.br/
	São Paulo	http://www.governoaberto.sp.gov.br/
Municipality	Fortaleza	http://dados.fortaleza.ce.gov.br/portal/
	Recife	http://dados.recife.pe.gov.br/
	Rio de Janeiro	http://data.rio/
	São Paulo	http://dados.prefeitura.sp.gov.br/

Moreover, the requirements compliancy was tested considering data related to indicators used by the United Nations (UN) to calculate the Human Development Index (HDI), which, according to the UN, can be used to enquiry public policy. This index relates health indicators (life expectancy at birth), gross national income per capita, and education indicators (average years of schooling) [49]. The use of HDI as an example in this study is justified by the global importance of the UN, as it is adopted by many countries around the world. In addition, the Open Government Declaration highlights the commitment of OGP member countries "to the principles enshrined in the Universal Declaration of Human Rights, the UN Convention against Corruption, and other applicable international instruments related to human rights and good governance" [27].

Table 5 lists the datasets characterized in this first case study and related Ids used in the result Table. Besides, the titles were presented in the Portuguese language once the portals did not provide the search in English. Nevertheless, the translated titles were also presented to broaden understanding.

Table 5 - List of Datasets characterized in the Case Study 1 and related Ids

Region	**Datasets (Original Title / Translated to English)**	**Ids**
Union	Indicadores sobre Brasil Alfabetizado / Indicators on Literate Brazil	1
	Indicadores sobre Ensino Básico – Estrutura / Indicators on Basic Education – Structure	2
	Indicadores sobre Ensino Superior / Indicators on Higher Education	3
	Indicadores sobre Saúde da Família / Family Health Indicators	4
	Produto Interno Bruto - Per Capita / Gross Domestic Product - Per Capita	5
	Índice de Desenvolvimento Humano / Human Development Index	6
Federal District	Desempenho Escolar / School Performance	7
	Nascimentos / Births	8
	Receitas / Recipes	9
	Despesas / Expenses	10
Alagoas	Anuário Estatístico de Alagoas 2017 / Statistical Yearbook of Alagoas 2017	11
Espírito Santo	Rendimento Escolar / School Performance	12
	Serviços de Saúde / Health Services	13
	Orçamento x Execução / Budget x Execution	14
Pernambuco	Produto Interno Bruto dos Municípios / Gross Domestic Product of Municipalities	15

Region	Datasets (Original Title / Translated to English)	Ids
	Coeficiente de Mortalidade Infantil / Infant Mortality Coefficient	16
	Índice de Desenvolvimento Humano Municipal / Municipal Human Development Index	17
Rio Grande do Sul	Taxa de Analfabetismo / Illiteracy Rate	18
	Expectativa de vida ao nascer / Life expectancy at birth	19
	Finanças públicas / Public finances	20
São Paulo (State)	Índice de Nível Socieconômico por Escola / Socioeconomic Level Index by School	21
	Mortalidade infantil / Infant mortality	22
Fortaleza	Índice de Desenvolvimento Humano / Human Development Index	23
Recife	Censo Escolar / School Census	24
Rio de Janeiro	Índice de Desenvolvimento Humano / Human Development Index	25
	Taxa de Analfabetismo / Illiteracy Rate	26
São Paulo (Municipality)	Índice de Desenvolvimento Humano / Human Development Index	27

3.3. Methodology of Case Study 2

In order to expand the characterization of the Open Data Initiatives from the Brazilian government, the second Case Study analyzed datasets available on the "Portal Brasileiro de Dados Abertos" (Brazilian Open Data Portal - http://dados.gov.br/) related to the indicators of International Organization for Standardization 37120 from 2014 (ISO

37120:2014). This portal contains a total of 6,873 datasets and links to Open Data Portals of other units of the federation (i.e. states, municipalities and the Federal District) [40].

The ISO under study was chosen specifically because it was used in previous works that related the concepts of Open Data and Smart Cities. These studies emphasized the importance of the evaluation between Open Data and indicators to provide quantitative measurements of city performance [50]. Another important feature of this standard is related to the idea that if citizens can have access to a standardized model of performance metrics, they can participate and support management activities, bringing governments and citizens together, and promoting transparent and participatory governance [51]. All of these aspects are directly related to the objectives of Open Government Data. Besides that, this international standard addresses areas considered key to improving public services and quality of life [52]. In addition to having been used in previous studies that aligned Open Data and Smart Cities, the ISO standard provides definitions, methodologies and metrics to promote the sustainable development of cities [32], [50], [53]. In this case study particularly, it was used to select the datasets to be characterized and to verify if the data related to the ISO indicators are openly available in compliance with the Open Government Data requirements according to the Table 3.

The ISO 37120: 2014 provides 100 indicators classified into 17 themes. The themes refer to the various sectors and services that structure cities and are the following: Economy; Education; Energy; Environment; Finance; Fire and emergency response; Governance; Health; Recreation; Safety; Shelter; Solid Waste; Telecommunication and innovation; Transportation; Urban Planning; Wastewater; and Water and Sanitation. This classification is not related to any type of hierarchy, it is used only to indicate the area of application of each indicator. Besides that, the standard emphasizes the importance of analyzing the various indicators related to a particular theme in an integrated way avoiding results with incomplete or distorted information. The indicators are divided in two classes: core and supporting. The ISO defines the core indicators as "required" and the supporting indicators as "recommended" to verify the performance of services to the population and the quality of life. According to the standard, these indicators allow to track and monitor the performance of cities. From the perspective of all the mechanisms that make possible the operation of the city, it is possible to use this information for sustainable development. This sustainability refers to the efficient use of available

resources and to the planning of future actions according to social needs [52]. In the characterization of the performed studied in the present work, this distinction between core and supporting indicators was not considered because the focus was on checking the compliance degree of the selected datasets.

Because the Brazilian portals do not offer the English language search option, and to characterize the datasets more broadly, the data related to the ISO indicators were searched in datasets related to the themes listed. In addition, although this ISO provides performance indicators for cities, some datasets may not reach this level of granularity, that is, they may be federative units, which are composed of sets of municipalities, or they may be broad with aggregate rates for the whole Brazil. Table 6 lists the datasets found and characterized in the Case Study 2. The titles presented for the datasets found are in the Portuguese language, however, for better understanding, the titles have been translated into English. For each dataset an Id used in the Result Table was provided for easy representation.

Table 6 - List of Datasets characterized in the Case Study 2 and related Ids

Themes	**Indicators**	**Related Datasets / Original Title / Translated to English**	**Id**
Economy	City's unemployment rate	Taxa de Desemprego / Unemployment rate	1
		Taxa de Desocupação / Unemployment rate - national research	2
	Number of new patents per 100 000 population per year	Patentes concedidas pelo Instituto Nacional da Propriedade Industrial / Patents granted by the National Institute of Industrial Property	3
	Youth unemployment rate	Indicador da Juventude - Taxa de Desemprego / Youth Indicator - Unemployment Rate	4
	Percentage of city population living in poverty	Famílias/Pessoas por faixas de renda per capita / Families / Population by income bracket per capita	5
Education	Percentage of students completing secondary education Percentage of students completing primary education Percentage of female school-aged population enrolled in school	Diagnostico da Juventude Temática Educação / Youth Diagnosis Education Theme	6

Themes	Indicators	Related Datasets / Original Title / Translated to English	Id
	Percentage of male school-aged population enrolled in schools Percentage of school-aged population enrolled in schools		
	Number of higher education degrees per 100 000 population	Pessoas com Escolaridade Superior / Population with Higher Education Degrees	7
Environment	Particulate Matter (PM10) concentration NO2 (nitrogen dioxide) concentration SO2 (sulphur dioxide) concentration	Emissões de Poluentes Atmosféricos / Air Pollutant Emissions	8
		Resultados de emissões nacionais de gases de efeito estufa / Results of national greenhouse gas emissions	9
	Greenhouse gas emissions measured in tonnes per capita	Estimativa de emissões dos gases do efeito estufa por mudanças de cobertura da terra da Amazônia Legal / Estimated greenhouse gas emissions from land cover changes in the Legal Amazon	10
Energy	Average number of electrical interruptions per customer per year	Indicadores de Qualidade de Energia Elétrica / Electric Power Quality Indicators	11
	Percentage of city population with authorized electrical service	Percentual de domicílios particulares permanentes servidos de energia elétrica / Percentage of permanent private households served with electricity	12
	Total residential electrical energy use per capita (kWh/year)	Receita e Consumo – Mercado Cativo de Energia Elétrica / Revenue and Consumption - Captive Electricity Market	13
	Percentage of total energy derived from renewable sources, as a share of the city's total energy consumption	Histórico do volume de energia elétrica produzida no país - classificada por fontes renováveis ou não / History of the volume of electricity produced in the country - classified by renewable sources or not	14
Finance	Debt service ratio (debt service expenditure as a percentage of a municipality's own-source revenue)	Dívida bruta do governo geral (% PIB) / General government gross debt (% GDP)	15
		Serviço da dívida dos Governos estaduais e do Distrito Federal / State and Federal District Debt Service	16

Themes	Indicators	Related Datasets / Original Title / Translated to English	Id
	Capital spending as a percentage of total expenditures	Despesa Orçamentária da União / Union budget expenditure	17
	Own-source revenue as a percentage of total revenues Tax collected as percentage of tax billed	Demonstrativos das Contas Anuais dos Municípios Brasileiros / Annual Statements of the Brazilian Municipalities	18
Governance	Percentage of women employed in the city government workforce	Censo do Legislativo / Legislative Census	19
Health	Number of in-patient hospital beds per 100 000 population	Leitos para internação por mil habitantes / Inpatient beds per thousand inhabitants	20
	Number of physicians per 100 000 population	Postos de trabalho médicos por mil habitantes / Medical jobs per thousand inhabitants	21
	Under age five mortality per 1000 live births	Mortalidade - Mortalidade Infantil / Mortality - Child Mortality	22
	Average life expectancy	Atlas do Desenvolvimento Humano no Brasil / Atlas of Human Development in Brazil	23
	Number of nursing and midwifery personnel per 100 000 population	Número de Equipes da Saúde da Família - ESF	24
Safety	Number of homicides per 100 000 population Violent crime rate per 100 000 population	Ocorrências Criminais - Sistema Nacional de Segurança Pública / Criminal Occurrences - National Public Security System	25
	Crimes against property per 100 000	Crimes Contra o Patrimônio / Crimes against Property	26
Shelter	Number of homeless per 100 000 population	Registro mensal das informações relativas aos serviços ofertados e o volume de atendimentos nos Centros de Referência da Assistência Social, Centros de Referência Especializados de Assistência Social e Centro de Referência Especializado para População em Situação de Rua / Monthly registration of information related to the services offered and the volume of attendances in the Reference Centers of Social Assistance, Specialized Reference Centers of Social Assistance and Specialized Reference Center for Homeless People.	27
Solid waste	Percentage of city population with regular solid waste collection (residential)	Percentual de domicílios particulares permanentes com lixo coletado	28

Themes	Indicators	Related Datasets / Original Title / Translated to English	Id
	Percentage of the city's solid waste that is recycled Percentage of city's hazardous waste that is recycled	Produtos Reciclados / Recycled Products	29
Telecommunication and innovation	Number of internet connections per 100 000 population Number of landline phone connections per 100 000 population	Conjunto de indicadores da área de Comunicações / Communications area indicator set	30
Transportation	Transportation fatalities per 100 000 population	Número de óbitos por acidentes de transporte / Number of deaths from traffic accidents	31
	Commercial air connectivity (number of non-stop commercial air destinations)	Vôos e operações aéreas - Dados Estatísticos do Transporte Aéreo / Flights and Air Operations - Air Transport Statistical Data	32
Urban Planning	Annual number of trees planted per 100 000 population	Florestas Plantadas / Planted Forests	33
Wastewater	Percentage of city population served by wastewater collection	Percentual de domicílios particulares permanentes com abastecimento de água da rede geral / Percentage of permanent private households with water supply from the general system	34
	Percentage of the city's wastewater receiving primary treatment Percentage of the city's wastewater receiving secondary treatment Percentage of the city's wastewater receiving tertiary treatment	Tratamento de Água / Water treatment	35
Water and sanitation	Percentage of population with access to improved sanitation	Painel de Saneamento / Sanitation Panel	36

4. Results and discussion

This section presents the results and discussion about the characterization of datasets extracted from the main Open Data portals of the Brazilian government, according to Case Study 1 and 2.

4.1. Case Study 1

In the first case study were analyzed 27 datasets distributed in Open Data portals of 11 regions of Brazil, named Federative Units and listed in the Table 5. The results of the analysis were defined as "Yes", "No" or "N/S", respectively for datasets that are compliant, not compliant or if there is no specification to safely determine if they are compliant with the respective requirement. Table 7 shows the compliancy results for all the datasets selected for this Case Study. From the 216 results, 132 indicated "Yes", that is, the datasets were in compliance with these requirements; 78 indicated "No" for requirements that were not satisfied; and 6 indicated "N/S", representing those cases where it is not possible to determine the compliance, since the information is not specified. It is concluded, therefore, that among the datasets analyzed, there is a 61% compliance with the Open Government Data requirements for the present analysis.

Table 7 - Results of the Case Study 1

Id	A	B	C	D	E	F	G	H
1	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
2	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
3	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
4	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
5	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
6	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
7	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
8	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
9	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
10	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
11	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes

Id	A	B	C	D	E	F	G	H
12	**No**	**No**	Yes	Yes	Yes	Yes	Yes	Yes
13	**No**	**No**	Yes	Yes	Yes	Yes	Yes	Yes
14	**No**	**No**	Yes	Yes	Yes	Yes	Yes	Yes
15	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
16	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
17	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
18	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
19	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
20	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
21	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
22	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
23	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
24	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
25	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
26	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
27	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes

In this case study, the datasets selected for characterization are related to the indicators used to calculate the HDI. When analyzing the datasets, some important information has been revealed. The datasets 1, 2, 3, 4, 6, specifically on the datasets download page, shows information that these datasets have not be updated since December 2014. The source is an Indicators Management Platform, which was created in 2010, which aggregated historical data from various federal agencies, and was deactivated in 2015 by the Presidency of the Brazilian Republic. Despite this, it is reported that data already registered would remain available. This information indicates a lack of compliance with two requirements: Timely and Primary, since the data is no longer being updated and is not collected at the source, at the maximum granularity and without modifications.

Another important information, also available on the download page of some datasets, is the lack of a License specification. Datasets 5, 18 to 21 and 23 contain the information "License not specified" or "Licença não fornecida" (in english, license not

provided). In this way, it is not possible to verify if these datasets are License-Free, which leads to the lack of compliance with this requirement.

All analyzed datasets are available for download, free of charge, for everyone and without any registration. These features support the Accessible, Non-proprietary, and Non-Discriminatory requirement, and report the compliance of all Portals with these requirements. In addition, they all provide download permission in xml, xls, json, or csv formats, which allow them to be read and processed by machines. This refers to the compliance with the Machine Processable requirement.

The datasets of the municipality of Espírito Santo were the only ones in compliance with the Timely requirement, allowing to make queries over recent data, from last month and year, as well from previous years. In addition, this portal presents Open Data information for all available datasets, in a standardized way, such as open specification, machine-processable CSV, and non-proprietary content. All other parsed datasets do not allow queries with this brevity of time.

Still on the requirement Timely, the Portal that most calls attention is the one of the state of Pernambuco. On the homepage of the Portal, it is possible to check the latest data. The first dataset in this list has a 2013 registration date, and it can be concluded that the most updated data of this Portal dates from 2013, and there is no information explaining why the data is no longer updated. All datasets on this portal, in addition to those that have been further analyzed, are therefore not in compliance with the Timely requirement.

No analyzed dataset presents a level of granularity in which it is possible to identify the public entity of origin that processed the data. In this way, the datasets always present some form of treatment before being made available. An example of this is the Gross Domestic Product of the Municipalities of the state of Pernambuco, which presents a list of municipalities and the percentage of participation of each one in the state's GDP. It is not possible to see the raw data that was made for these calculations, not even the public bodies that provided the data for the calculations. This results in the lack of compliance of all analyzed datasets with the Primary and Complete requirements.

From the calculation of the percentage of compliance for each requirement, we can have a more specific view of what really needs to be identified so that datasets can be

aligned with OGD goals. From this calculation it is possible to identify the gaps between the requirements and the Open Government Data initiatives in the context of the analyzed datasets. These results indicated that for the Accessible, Machine Processable, Non-discriminatory, and Non-proprietary requirements, all the analyzed datasets are 100% compliant; the Complete and Primary requirements were not satisfied by any of the analyzed datasets; for the Timely requirement the result was approximately 11% of compliance; and, lastly, there is approximately 78% compliance with the License-free requirement.

4.2. Case Study 2

The Case Study 2 characterized 36 datasets listed in the Table 6. The characterization of compliance with the requirements defined in Table 3, followed the same procedure as for the Case Study 1. The difference was the selection of datasets related to ISO 37120: 2014. From a total of 288 records, as shown in Table 8, 108 had "No", indicating no compliance with the requirement; 174 had "Yes" indicating compliance with the requirement; and 6 had "N/S", which means that there is no way to indicate compliance due to a lack of specification in the analyzed dataset. Therefore, within the context analyzed, the datasets showed approximately 60% compliance with the OGD requirements.

Table 8 - Results of the Case Study 2

Id	A	B	C	D	E	F	G	H
1	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
2	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
3	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
4	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
5	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
6	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
7	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
8	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
9	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
10	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes

Id	A	B	C	D	E	F	G	H
11	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
12	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
13	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
14	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
15	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
16	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
17	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
18	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
19	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
20	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
21	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
22	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
23	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
24	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
25	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
26	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
27	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
28	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
29	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
30	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
31	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
32	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
33	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
34	**No**	**No**	**No**	Yes	Yes	Yes	Yes	**N/S**
35	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes
36	**No**	**No**	**No**	Yes	Yes	Yes	Yes	Yes

The results showed that none of the datasets analyzed in this Case Study are compliat with the Complete, Primary and Timely requirements. On the other hand, they all are 100% compliant with Accessible, Machine Processable, Non-discriminatory and Non-proprietary requirements. As for the License-free requirement 6 datasets did not provide

information to guarantee compliance, therefore, the datasets analyzed are approximately 83% in compliance with this requirement.

These results are very similar to the results analyzed in Case Study 1. First, because the total compliance result of the first study was 61%, while in this case was 60%. Besides that, both studies have shown that the Timely, Complete, Primary, and License-Free requirements are the ones with some degree of nonconformity and are therefore the ones that must be observed for OGD implementation to be truly effective. Although these results cannot be generalized, given the much larger number of datasets available in portals, it is possible to observe a pattern in the degree of compliance with OGD requirements.

Another important result which can be extracted from this Case Study is that, from the total of 100 indicators investigated, 36 datasets related to these indicators were found and characterized. The results showed that datasets related to 55 indicators were not found. It is important to note that some datasets contain data that supports more than one indicator. Therefore, the datasets selected provide data related to 45 indicators or 45% of the indicators listed in ISO 37120:2014.

Table 9 - Percentage of Indicators with analyzed datasets grouped by themes

Themes	**Total Indicators**	**Indicators Not Found**	**Indicators Found**	**Indicator Found (%)**
Economy	7	3	4	57%
Education	7	1	6	86%
Energy	7	3	4	57%
Environment	8	4	4	50%
Finance	4	0	4	100%
Fire and Emergency response	6	6	0	0%
Governance	6	5	1	17%
Health	7	2	5	71%
Recreation	2	2	0	0%
Safety	5	2	3	60%
Shelter	3	2	1	33%
Solid waste	10	7	3	30%

Themes	Total Indicators	Indicators Not Found	Indicators Found	Indicator Found (%)
Telecommunication and innovation	3	1	2	67%
Transportation	9	7	2	22%
Urban Planning	4	3	1	25%
Wastewater	5	1	4	80%
Water and sanitation	7	6	1	14%

Table 9 show the percentage of indicators within each theme for which the Brazilian Open Data Portal provides related datasets. Based on this information, it is possible to identify the areas that need more efforts to make Open Data available, in case a given Public Administration has the objective of evaluating governance performance according to ISO 37120: 2014. The indicators of this standard are used in this Case Study only as an example of areas that can be considered as a grouping of performance indicators for public services. In addition to providing resources for internal performance evaluation, they also present data that can be used by citizens, for example, for greater participation in government. Improving internal efficiency by monitoring performance and enabling the monitoring of public services by citizens are some of the objectives of Open Government Data.

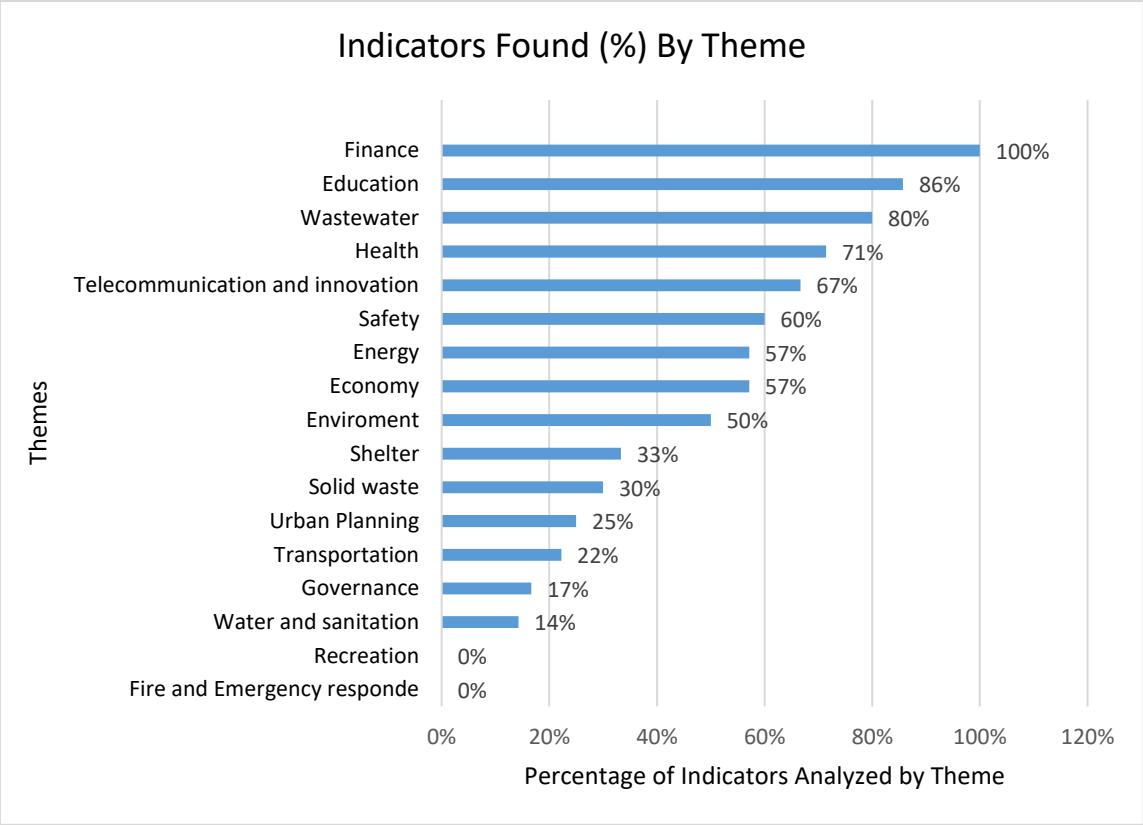

Figure 4 - Percentage of Indicators Found by Theme

Figure 4 shows the percentages provided in Table 9 in a chart view. The chart is one of the ways of presenting and visualizing results that can support a data-based decision process. In this case, it is observed, for example, that no data were found on the "Recreation" and "Fire and Emergency response" themes. With this information, it is evident that there are no Open Government Data initiatives in these areas or, if they exist, none were found. On the other hand, for the "Finance" theme, data related to all the indicators presented by the standard were found, and maybe it is possible, therefore, to evaluate the set of indicators related to this area and extract information that may be used in data-based decisions.

Some visualizations can be extracted from datasets characterized. These visualizations are evidences that it is possible to extract information that can be used as a basis for better informed decisions. Besides that, it is a way of demonstrating that OGD initiatives can result in more efficient government and citizens more aware of government actions. On the other hand, they show that the lack of compliance with all Open Data requirements can make it difficult or even impossible to reuse or integrate these data.

In order to exemplify, Figure 5 was developed from the dataset "Taxa de Desemprego" or "Unemployment Rate". This dataset provides the rates already calculated for each state between 2009 and 2014. With these data, the averages of the rates by state were calculated. The result showed that the highest average belongs to the state of Amapá, and the lowest in the state of Santa Catarina.

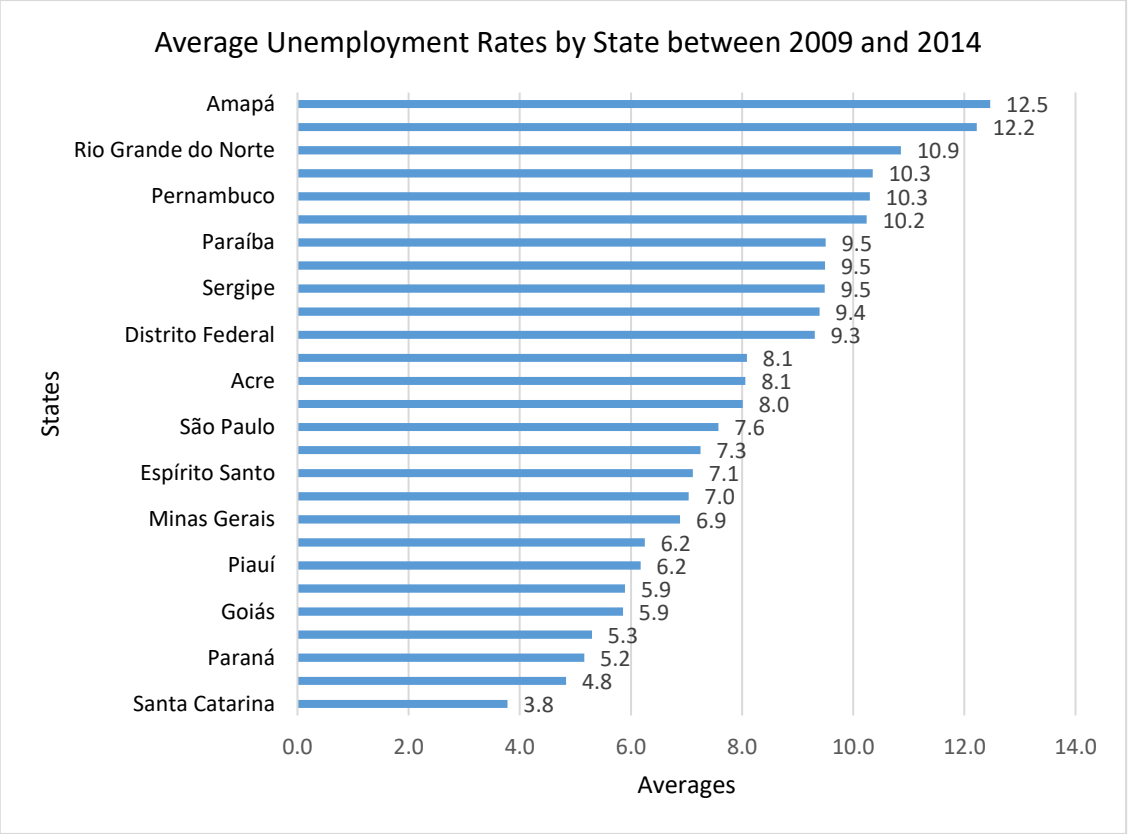

Figure 5 - Chart with the Averages by States

Still with this same dataset, and already with this information about the highest and lowest average between the states, a second chart was developed and shown in Figure 6, allowing the visualization of the evolution of the unemployment rates in each year for the states of Amapá and Santa Catarina. From this view, it is possible to see the great difference that exists between these states. With this information, the government can, for example, make decisions that result from identify the reasons for these differences and use mechanisms to reduce unemployment rates and make the social indicators of states less unequal.

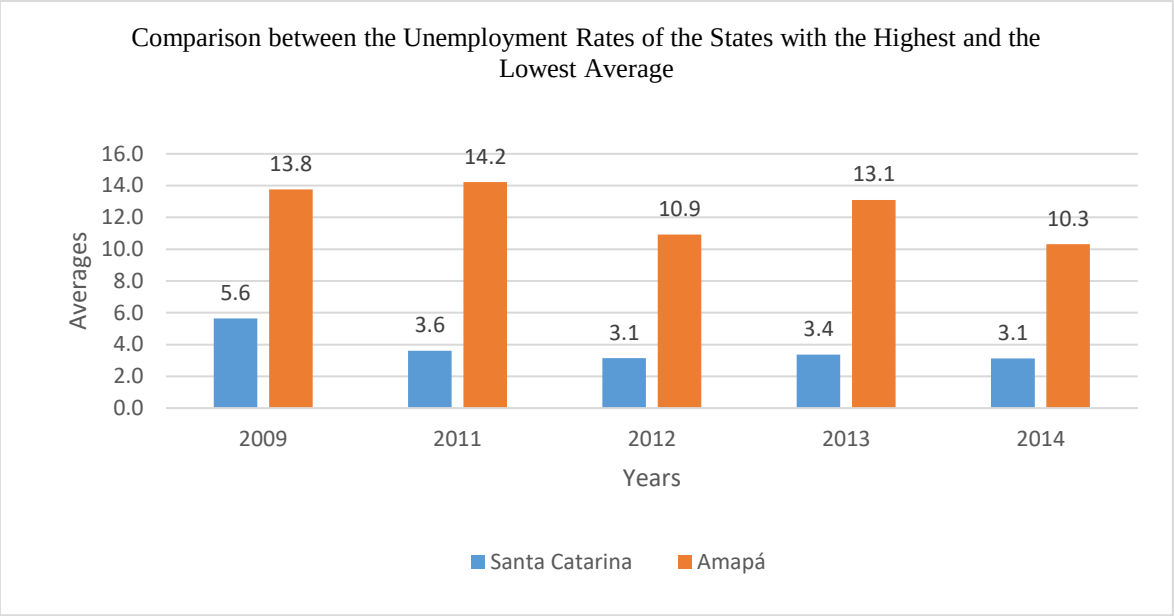

Figure 6 - Chart with the Averages by Years of the States of Santa Catarina and Amapá

5. Conclusions and future developments

The main objective of this work was to characterize the degree of conformity of the OGD initiatives in the main Open Data portals of the Brazilian government. Through the developed case studies, it was possible to identify requirements and areas of government actions that need to be better observed so that these initiatives can be effectively implemented and provide the expected results.

In order to reach this result, it was possible to identify how the tendency towards OGD initiatives has grown over the last decade, in different ways in different countries and how the technological evolution, especially the one related to ICT, further drives these practices. However, despite the differences, it is possible to identify the main objectives that drive these initiatives, especially transparency, accountability and popular participation. These initiatives are already demonstrating changes in the area of governance, as the focus on citizens and quality of life is increasing. Moreover, it was observed how the opening of government data contributes to the deepening of democracy, which was also seen as a trend in countries around the world.

Another important result of this work was the identification and differentiation of different terminologies and practices that have been implemented to develop best governance practices associated with technology, such as Electronic Government, Open Government and other concepts related to the OGD.

The various international organizations formed by bringing together a growing number of countries around the world are creating ways to boost OGP. It was observed that in the documents used to encourage these practices, the citizen and democracy are always in focus. Another common goal observed was economic growth and the development of innovations.

The present work demonstrated how OGD initiatives have evolved along with the technological evolution itself. As technology continues to evolve, these initiatives also change, and need further study. And as it is evolving, it has fertile ground for further research.

It was observed, for example, that despite the numerous potential benefits that researchers point out to OGD initiatives, there are still few studies that actually prove

them. Therefore, more studies need to be done to understand the direct relationship between the initiatives and the expected benefits.

It is planned to analyze how citizens are aware of what government data are available, as well as to analyze what use is being made from this openness government data. This is because, as noted, just making data available does not bring the expected benefits of OGD. This data needs to be reused to justify the investment in making it available.

Continuing to identify challenges, barriers and gaps that hinder data interoperability and reuse so that these initiatives can become more effective is also essential for OGD results to be effectively harnessed, identified and improved.

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