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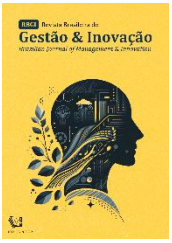

Open Government Data and Service Innovation

Dados Governamentais Abertos e Inovação em Serviços

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HIGHLIGHTS

- The study maps how Open Government Data (OGD) supports service innovation by identifying necessary conditions, process stages, and expected outcomes. It proposes a general innovation process model that can guide future empirical research and practical OGD initiatives.
- Using a qualitative two-phase methodology, the research combines expert interviews and four Brazilian case studies. This approach reveals barriers, required resources, stakeholder roles, and real applications of OGD in both public and private service contexts.
- Findings emphasize data quality, multidisciplinary teams, long-term planning, and stakeholder cooperation as critical enablers. Poor standardization, weak open-data culture, and resource scarcity appear as major obstacles limiting the effective transformation of OGD into innovative services.
- The cases demonstrate diverse innovation outcomes, including social control tools, evidence-based public management, political intelligence services, and hospital decision support systems. OGD proves capable of generating public value, new business opportunities, and improved organizational performance.

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ABSTRACT

Purpose: This article seeks to map how open government data (OGD) can support service innovation.

Design/methodology/approach: To do so, a qualitative study was carried out, in which the researchers collected information from Brazilian specialists. The research was divided into two phases. Firstly, specialists were consulted regarding how OGD should be generated and disseminated in order to support innovation. Secondly, information from OGD-based projects was collected to obtain insights into how new ideas or solutions to problems were implemented.

Findings: The main result is a map of the OGD-based innovation process that describes the conditions necessary for OGD to be used for innovation as well as the steps for the effective development of innovations.

Originality: The process described in the paper is a general map that can be used in future research as a basis for investigating OGD-based innovations. The main difference in relation to other innovation processes is related to the particular features of the OGD ecosystem.

PALAVRAS-CHAVE

Dados Governamentais Abertos

Inovação

Inovação em Serviços

RESUMO

Objetivo: Este artigo busca mapear como os dados governamentais abertos (OGD) podem apoiar a inovação em serviços.

Desenho/metodologia/abordagem: Para isso, foi realizado um estudo qualitativo, no qual os pesquisadores coletaram informações de especialistas brasileiros. A pesquisa foi dividida em duas fases. Primeiramente, especialistas foram consultados sobre como os OGD deveriam ser gerados e disseminados para apoiar a inovação. Em seguida, foram coletadas informações de projetos baseados em OGD para obter percepções sobre como novas ideias ou soluções para problemas foram implementadas.

Resultados: O principal resultado é um mapa do processo de inovação baseado em OGD que descreve as condições necessárias para que os OGD sejam utilizados para inovação, bem como as etapas para o desenvolvimento efetivo de inovações.

Originalidade: O processo descrito no artigo é um mapa geral que pode ser utilizado em pesquisas futuras como base para investigar inovações baseadas em OGD. A principal diferença em relação a outros processos de inovação está relacionada às características particulares do ecossistema de OGD.

1. Introduction

Open government data (OGD) is a relatively recent phenomenon. Since the beginning of the 21st century, various governments around the world have begun to make data available to the public in response to demands for transparency (Yang; Liu & Chen, 2023; Zhenbin et al., 2020). While initially the generation and dissemination of OGD was aimed at attending demands for greater transparency and accountability (Attard et al., 2015), over time, OGD has been increasingly used for other purposes, such as innovation (Gascó-Hernández et al., 2018).

Since the first research initiatives, in mid-2010, researchers have considered how OGD can be used for innovation (Ubaldi, 2013; Lee and Kwak, 2012). Even so, most studies have focused on topics such as: the objectives for initiatives using OGD (Zuiderwijk et al., 2019), policies for innovation with OGD (Ingrams, 2017), encouraging the use of OGD (Jaakola et al., 2015), new techniques for opening data (Sayogo et al., 2014), thus, the use of OGD in the innovation process remains incipient.

Open government data facilitates innovation (Caprotti et al., 2014; Gonzalez-Zapata and Heeks, 2015) and can be seen as an input to innovation (Attard et al., 2015). However, empirical research that validates how this process occurs is still subject to development, for the consolidation of the topic in the literature. How OGD generates innovation has mainly been studied in the advanced economies (Capdevila and Zarlenga, 2015; Kassen, 2018), which demonstrates the need for studies in different contexts for a broader understanding of the phenomenon. Empirical studies that validate the assumptions of the studies that refer to the possibility of innovation with OGD (Ruijer and Meijer, 2019) are still scarce in the literature (Safarov et al., 2017). The mechanisms by which OGD contribute to the innovation process require greater empirical validation (Nam, 2015; O'Riain et al., 2012).

It is important to map the origins of innovations and understand the path taken between the generation of ideas or the solutions to problems until the introduction of innovations (Weerakkody et al., 2017). It is important to look at the OGD-based innovation process because of the particular characteristics of the OGD ecosystem (Bäckström and Bengtsson, 2019). One such characteristics is that OGD can contribute to innovations in the public or private sector, due to their ability to generate new information, and come from direct government actions, making this ecosystem different from traditional innovations (Väyrynen; Helander and Jalonen, 2023).

Generating innovations is a complex process that involves dealing with a multifaceted environment and several stages of planning and execution ((Väyrynen; Helander and Jalonen, 2023). The environment in which innovation occurs differs from the traditional one, even considering the diversity and specificities of the application of OGD (2014; McNutt et al., 2016). Empirically mapping the stages of the innovative process with OGD provides a more in-depth understanding of this ecosystem and its particularities (Kaschesky and Selmi, 2014). The present research involving studies with OGD, thus offering an overview of the research conducted to date and the incipient research into the role of OGD in the innovation process (Bäckström and Bengtsson, 2019; Ruijer and Meijer, 2019; Zuiderwijk et al., 2016).

Considering the above-mentioned problem and the theoretical references adopted herein, the aim of was to empirically map how OGD data can support innovation processes. The field study was qualitative and divided into two phases. In the first phase, we sought to understand the conditions necessary for OGD to help innovation. The second phase was dedicated to four case studies which provide insights into how OGD have been applied to develop innovations.

2 Open government data and innovation

Open government data provide for increased social control with greater transparency, encourage the exercise of citizenship, can create solutions or even improve public administration (Yang; Liu & Chen, 2023) and aid the development of innovation in general (Thorsby et al., 2017). It is worth considering their capacity to generate public value and/or the increase of economic activities, with the creation of new products or services that generate value for society (Attard et al., 2015; Linders, 2013). Government acquires a new role in this ecosystem, exercising a new government function by generating and disseminating data and information relevant to society (Scholl, 2013).

Innovations resulting from the reuse of OGD, although something relatively new, have the capacity to generate new ideas or solutions to problems that involve the public sector, society, companies and other organizations (Dawes et al., 2016). Such organizations can benefit from OGD by increasing the accuracy of decision making, with OGD constituting a source for evidence-based management (Zuiderwijk et al., 2016).

Recombining OGD with proprietary data or other sources enhances the value creation that OGD can generate (Gallouj and Windrum, 2008). Stakeholder participation in the innovation process becomes important in line with more modern views of innovation (Dwivedi et al., 2017; Weerakkody et al., 2017).

Public policies define the guidelines for the generation and dissemination of OGD, but in order for them to be effective for innovation, one must be aware of the particularities of this process (Ingrams, 2017; Sadiq and Indulska, 2017; Zuiderwijk et al., 2019). Guidance for those requesting data for innovation is essential in order for OGD to be useful in innovation processes (Zuiderwijk et al., 2019).

Variables that involve the innovative process with OGD have been the subject of academic discussion and emerge (Väyrynen; Helander and Jalonen, 2023), in addition to other aspects, in the results of this investigation (see results). Among these variables, the following stand out: a) long-term planning is recommended for the effectiveness of projects with OGD (Kaschesky and Selmi, 2014); b) human and material resources (Gascó-Hernández et al., 2018; Rana et al., 2017; Zuiderwijk et al., 2019); c) training to obtain information from OGD and generate innovations (Gascó-Hernández et al., 2018; Kassen, 2018); d) the participation of society (bottom-up) (Capdevila and Zarlenga, 2015; Roy, 2014); e) the generation of new ideas or solutions (Weerakkody et al., 2017).

3 Method

The study consisted of two empirical and qualitative phases. The first sought to determine the conditions for OGD to be applied in the development of service innovations. The second focused on understanding how the OGD have been used in service innovation projects and the resources and barriers encountered in achieving the results (benefits) in four cases.

In both study phases, the interviewee selection criteria were previously defined to ensure the recruitment of participants with a minimum amount of time and experience working with open data. The requirements of the career area were: professionals who had worked for at least five years in one of the following areas: technology, law, administration or economics. Those selected had worked on projects or research involving OGD for at least three years, given that the topic is relatively recent.

3.1 Data collection and analysis

The data were collected with forty-six professionals that fitted the profile were contacted. During the seven months of collection, there were twenty-two respondents in total. For the first phase, four face-to-face interviews, with an average duration of 29 minutes and 40 seconds, and eighteen interviews via Whatsapp® (audio), with an average duration of 28m36s, were conducted. The data analysis is described in sections 3.2 and 3.3, due to the different collection and analysis processes. The first phase consisted only of interviews, while the second included interviews, website analysis and the use of the applications.

3.2 Description of phase 1

The data collection instrument developed for the first phase addressed issues such as: barriers to OGD-based innovation (Sheth and Ram, 1987), characteristics of stakeholders in OGD-based innovation projects (Kaschesky and Selmi, 2014), the characteristics of human resources (Davies and Edwards, 2012), the characteristics of innovation projects (OECD/Eurostat, 2018), and the expected result of using OGD in innovation (Zuiderwijk et al., 2016).

The interviewees were fifteen Brazilian professionals specialized in OGD. Audio recordings were made of the interviews which were later converted into text for analysis. The data analysis was performed with the support of the Atlas TI® software and in accordance with Flick (2009), the interviews being transcribed and coded. The codes were grouped according to the pre-defined themes, which served as the basis for creating a map with the links between the themes.

3.3 Description of phase 2

In the second phase, involving case studies of OGD-based projects, the instrument included questions about: the aspects that gave rise to the OGD-based innovations - motivations and new ideas or solutions (Smith, 2008), barriers to the use of OGD for innovation (Seth and Ram, 1987), the necessary resources (Gallouj and Savona, 2008) and the results obtained with each of the applications (benefits) (OECD/Eurostat, 2018) that determine the innovative nature of each project.

The project teams were composed of up to four professionals. However, for each case study, the main interlocutor was sought in order to obtain a wider range of information and favor its quality and objectivity. Data collection was carried out through interviews and followed the same procedure as in phase 1. Again, Atlas TI® software was used in the coding to extract the themes, thus creating a map that describes the findings.

4 Results and discussion

In this section, the two phases of the study are described and analyzed. At the end of the analysis, the map shows the generated codes arranged in sequence starting with the driving idea or problem solution and ending with the results achieved with each application. Thus, it is possible to connect the maps and themes indicating the conditions necessary that allow OGD-based innovation can occur with the results of the cases.

4.1 What conditions are necessary for OGD to generate ideas or solutions?

This section presents the results of the first phase, which comprises the conditions necessary for OGD to generate innovations. The first theme brought together the codes representing barriers to OGD-based innovation, which are subdivided into structural (codes 1, 2, 3) and behavioral barriers (codes 4, 5, 6).

The codes generated included: 1) Poor quality OGD in Brazil - Referring to the principles of OGD quality (Gascó-Hernández et al., 2018) that have not been not fully met by Brazilian governments. Non-standard data is reported as a recurring problem that affects operational capacity when cross-referencing or handling OGD. The poor quality or lack metadata creates difficulties for interpretation. An example being the public finance departments that use acronyms and technical nomenclatures but fail to provide metadata to explain the terminology, so users who do not work in the public sector have difficulty understanding the data; 2) OGD exclusively for transparency - The experts' perception is that the country has not yet woken up to other uses of OGD, such as for innovation processes; 3) Project discontinuity - The results showed that even when OGB-based innovation initiatives exist, projects tend to be discontinued due to lack of resources, lack of motivation from the creators, lack of public or private incentives for the development of updates or maintenance of created systems, and/or low use of the applications by citizens or organizations.

With regard to behavioral barriers, the codes mentioned included: 4) Resistance to data disclosure – This refers to the reluctance on the part of public officials to disclose OGD, due to a feeling that they own the data; 5) Cooperation for OGD-based innovation (Kassen, 2018) - In the OGD ecosystem it is necessary to foster cooperation between developers, citizens, organizations and government. The interviewees point to a characteristic lack of cooperation inherent in Brazil, a country that has not yet developed a more fruitful environment for cooperation in the use of OGD. For OGD-based innovation processes, effective cooperation between stakeholders is needed, especially between public managers and OGD users. The low interaction between actors (Gascó-Hernández et al., 2018) shows it is imperative to have open channels of communication and interaction, which have not been well developed in Brazil due to a deficient interaction structure, especially due to attitudes that do not favor cooperation. An example of such a situation is the requests for information or questions are sent to government agencies, when response time is usually long, from days to months, and sometimes they go unanswered. This is attributed to structural difficulties and lack of training or unwillingness among public officials; 6) Culture of data openness (McNutt et al., 2016) – Refers to the lack of a culture of open data on the part of government and both citizens and organizations (Capdevila and Zarlenga, 2015) due to a perception of low involvement of stakeholders with OGD, both among organizations and citizens. The incipient nature of OGD use is also reported, which is reflected in the immaturity of Brazilian policies for OGD and also the ignorance of these data by citizens and organizations. Most OGD are made available by federal agencies and refer to health and education, and even when states and municipalities provide OGD, problems with data reliability and standardization demonstrate the OGD culture is ineffective because there is, as yet, no awareness of the importance of meeting principles of quality.

The theme human resources for projects is about achieving a better understanding of what characteristics are needed for professionals to work with OGD-based innovation, the codes include: 7) Multidisciplinary teams – This aspect was seen as crucial because it is not enough to know about technology alone, there is a need to understand the context of the innovation and have a regulatory and legal perspective, as well as administrative and data science knowledge. This demystifies the role of the data scientist, who cannot necessarily solve everything alone, other skills and knowledge from areas such as administration, law, economics, engineering, architecture, design, etc. are needed. The skills and competencies of a team enable better results in OGD-based innovation projects. 8) Motivation for OGD analysis - Professionals must be driven by will when working with complex data and contexts. In addition to having technical capabilities, it includes a behavior favorable to the manipulation of these data. This trait is perhaps the most important in the Brazilian context in view of the structural and quality difficulties of the verified OGDs; 9) Training for OGD analysis (Gascó-Hernández et al., 2018) - In view of the aforementioned knowledge (multidisciplinary team) professionals need to master those specialist areas to ensure better performance. The skills mentioned included analytical skills, treatment skills, cleaning and data quality assurance, and an understanding of the relevant legislation, knowledge of ICTs. Another relevant factor is an awareness of the origin, nature and meaning of the disclosed data, to develop the solutions or apply the new ideas are relevant aspects to develop the innovations.

With regard to the characteristics of innovation projects, the particularities of OGD-based innovation are considered, such as: 10) Long-term projects (Kaschesky and Selmi, 2014) - OGD do not produce immediate results, planning, technological structure and time for course adjustments and corrections are all necessary; 11) Use of OGD demands more OGD - When creating an OGD-based innovation project, frequently other demands arise and projects may require new data for their continued evolution. An example of this situation would be an OGD-based project that when launched and used by other people, receives unexpected or previously unmapped uses. The interaction between stakeholders (Kassen, 2018) and the application creates new ideas that can feed back into the development of the application.

Finally, the expected product of the OGD-based innovation consists of the initial result of using OGD and comprises the creation of solutions (12) and generation of new ideas (13) (Weerakkody et al., 2017). This last item can be seen as a consequence of the previous ones and links the generation and dissemination of OGD with the subsequent process, namely, the development of innovations. New ideas or solutions (Zuiderwijk et al., 2016) kick-start the process of creating innovations. The process of developing an innovation is permeated by specific variables (Smith, 2008) that are discussed below in the case studies.

In view of the results obtained in step 1, investigation was continued in order to generate the map that links the conditions for OGD to be used for innovation and the construction of the innovations themselves. The next section describes four cases, with the results being discussed in a later section.

4.2 Case studies

The second, similarly qualitative, phase of the study aimed to study practical cases of using OGD to develop innovative solutions, regardless of the level or impact of that innovation (OECD/Eurostat, 2018). An example of this are the motivations for using OGD to create something new or useful for society. In this theme, several motivating aspects came together, such as a new professional challenge, desire for citizen participation, for example. Based on the interviewees' reports, the motivations were understood to be linked to other codes: generating new ideas and problem solving. The subsequent phases showed the results achieved with the application and intervening aspects such as barriers and the required resources.

4.2.1 Case 01 - Monitoring the activity of members of parliament

This application uses data generated by the Federal Chamber of Deputies to monitor the activities of the lawmakers in the parliament which provides data on the total expenses of each MP, including amendments, absences, participation in committees, use of functional property, whether they receive housing assistance and the total amount in Reais (Brazilian currency) that they receive, projects they are involved in and their Twitter messages, they correspond to the theme "aspects that inspire the creation of OGD-based innovations".

The application was developed due to the availability and willingness of its creator, who, in addition to being the only professional to work continuously on the development of the application, invested his own resources in infrastructure items (software and server rentals). The availability of the open data and the desire for professional challenges motivated the developer to create the application. At the recommendation of a friend, he became familiar with the database of the Federal Chamber of Deputies and saw the opportunity for a professional challenge while creating something new and beneficial to society, disseminating data in a more palatable way to the citizen.

The scarcity of both financial resources and professionals to carry out the work voluntarily are the main barriers limiting the development of the application and the expansion of its use as a mechanism of social control. Attempts were made to enroll professionals to work on the application voluntarily, but they were unsuccessful. Due to the specific nature of this application, its target audience and objectives for the use of public data (social control exercised directly by the citizen) required more professionals than material resources per se.

The professional also suggests there is a need for a multidisciplinary team to keep the application fully operational. The ideal profession team to maintain the application would consist of a designer, fundraiser, and a technology professional. The application focuses on providing information to citizens in an open and accessible way, thus allowing citizens to more closely monitor their representatives in parliament and exercise their citizenship.

In this case, it is noteworthy that the initiative came from an independent developer for the purpose of social control. Because the initiative did not receive financial support from society, government or other organizations, it became dependent solely on its developer, which weakens the long-term prospects of the project. Even though the focus is on social control, it represents a more suitable way of making the OGD available to stakeholders, compensating in some way for government failures in the generation and availability of data.

4.2.2 Case 02: social indicators

The study was conducted within a Public Ministry of a State in southern Brazil, based on a project that aimed to systematize and facilitate access to social indicators. The application was originally conceived 12 years ago and has been fully operational since April 2015. The original problem was the lack of a OGD-based project to support decision making. In mid-2008, applying strategic mapping, the aim was to include actions based on evidence (Safarov et al., 2017) in order to improve the social conditions in the state. At that stage, they had no applications and began to study social indicators to generate information and promote policies focused improving society.

The idea was to bring together indicators from various sources (education, justice, security) into one place to facilitate data analysis. As of 2012, new technological tools (Business Intelligence) demonstrated the feasibility of the idea. The project members carried out source mapping of the indicators and the checked the reliability of the data. Consequently, in 2013, the project started with a database of health and education indicators. The idea arose to make these data available to public prosecutors who work closely with social demands.

In that period, reports were produced for each district, with information on health, education and public safety. To the surprise of the project managers, other government agencies started using the application. In some cases, data from certain other public agencies were analyzed in the application because they were more palatable and easier to use than the raw data in presented spreadsheets. Then came the idea of creating a web application that would allow rankings, comparisons, and the cross-checking of indicators that would be accessible to all citizens. The data makes it possible to monitor the results of social actions using indicators such as school absenteeism and attendance, and crime rates.

There has been unplanned learning throughout the development process because the application has been molded over time until it reached its present form. The development process, despite being empirical and unplanned, was similar to the use of agile methods. At each stage in the development of the application more resources and specialized professionals were provided for its evolution and structural improvement. Some examples of the barriers encountered and overcome in developing the application, include: non-standardized data from multiple OGD sources, with unclear or difficult to manipulate metadata – which means it takes a long time to analyze the indicators. In addition, the project creators sought to serve a wider range of areas, but point out that more qualified labor is needed to do so.

The material resources include BI tools, programming software, computers, and a data center to host the application. The human resources (technical labor) were considered most important. The professionals required include specialists in management, information technology, law, economics and design, which together form a data science team because it is impossible to find all the skills in one person.

As for the results, the application mainly provides generic data, but it allows people to follow the evolution of social indicators. The application provides accessible information on the social situation, based on macro indicators and enables dialogue between the Public Ministry, other agencies within the judiciary, and the executive and legislative branches of government. This interaction enables the identification of social problems. Such problems can be solved through actions by public agencies and public managers.

The construction of the application has led to the creation of specialized prosecutors, such as that for education. The application facilitates social control, because it gathers the data in one location, with data display and manipulation resources that facilitate understanding and accessibility by managers, technicians, researchers and the wider public. The use of the application has led to new ideas, such as the use of public safety data in a case in which data on violence in the city was used to support the prosecutor's arguments.

One of the prosecutors uses the data to support a legal opinion, which adds objective information to the argument. The application has ended up being used for purposes that were not thought of beforehand and allows citizens to explore specific data as they wish. The more the user delves into the information generated, the more data is demanded, impelling the government to provide more open data. Internally, in this government agency, the results of the project encouraged the creation of a data analysis and innovation laboratory.

This case is an example for the Brazilian OGD ecosystem and has shown its applicability due to the capillarity the initiative has generated. By providing data in a palatable way, multiple possibilities for using that data have emerged, enabling improvements in public management and social control. As with Case 01, this project also compensates for government failures by reorganizing data, which would not be necessary if the data made

available by the government conformed to the OGD quality principles widely disseminated in the literature.

4.2.3 Case 03: Political intelligence system

The application/software appeared in mid-2014 and was designed to provide citizens with access to governmental information. After creating the application and making the information available to citizens, the creators noticed the low level of use by the general public. Instead, the application has been taken up by a more specific user group, namely public relations professionals and professional advocates i.e. lobbyists dedicated to defending the interests of organizations.

The initial idea led to a business opportunity based on serving these two audiences, from which comes the current version of the application that monitors the activity of the legislature, thus facilitating the management of political and regulatory risk. It is an application that was originally conceived as a means of exerting social control and encouraging participation that has become a political intelligence system for decision making.

The material resources used were those commonly used in the development of an application, namely software, and rented servers and PCs. As for human resources, the team comprises technology and legal professionals, the latter having contextual knowledge while also performing administrative tasks.

The two main barriers encountered are related to financial resources and poor data quality. The scarcity of the financial resources to start the project, consisting of the creators own capital, illustrates an important infrastructure difficulty. The data quality problems cited were: data organization, the constant alteration of virtual addresses used by government agencies, infrequent data accessibility due to the lack of metadata, the lack of a standard for making data available and the constant instability of government websites.

The results provided by the application include aspects that, from the business point of view, are interesting, since a political intelligence system was created that furnishes information for decision making by enabling the management of information from the legislature. The transformation of the application has led to objectives being added in relation to the initial idea, with a new service that meets the specific demands of a niche market.

Unlike cases 01 and 02, this case involves the transformation of what was originally conceived as a social control mechanism into a new business product. This transformation demonstrates the inventiveness and business vision of the inventors, which can be seen as a creative way to innovate. Occupying a new market niche or even creating a niche with the use of OGD is a way of generating new business and an OGD-based application that may interest private enterprise. New business can be generated with the application of OGD in other initiatives, the present case being a practical demonstration of this possibility and of the importance of encouraging the application of OGD in businesses.

4.2.4 Case 04: Hospital management using OGD

This case involves a recently expanded hospital in the western region of the State of Paraná, Brazil that provides services for the SUS (National Public Health System), health insurance providers and private patients. The original motivating idea was to meet the Ministry of Health criteria for the hospital to be classified as a philanthropic organization, which ensures tax benefits. The OGD started to be used in scientific work as secondary data to be analyzed and compared with data collected by the hospital's researchers. In the hospital management process, the data made available by the SUS are crossed with each other or with data collected by the hospital to support decision-making.

The use of the SUS data, despite its limitations, has contributed to more accurate support for decisions, for example, in identifying the training needs. Analyzing the data may reveal an increased demand for a medical specialty or procedure in the region. Thus, the hospital can invest in training professionals or adapting its structure to meet such emerging demands.

The material resources listed were PCs, software and the Internet, which are simple to obtain, do not require major structural adjustments, but need financial support. On the other hand, trained personnel to use OGD and cross-check information was considered the most important resource. In other words, even with the data available, without trained personnel it would be much more difficult to understand how to use it. The team working with the OGD consists of four IT professionals (who capture and generate the information) and two managers. This multidisciplinary team is set up to deliver relevant information to decision makers.

The barriers to innovation encountered involve data quality and the lack of the use of artificial intelligence to generate the data. Regarding the quality of the data, among the failings mentioned were inadequate financial information on procedures and services and an over-simple database with few data categories. The lack of use of artificial intelligence is reflected in the data quality.

The results obtained using OGD are described as: a) OGD - addresses training demands, and anticipates the demand for medical specialties by checking for trends in more prominent medical specialties in the country or region; b) Secondary data for scientific studies - OGD contribute to scientific studies in the hospital, providing researchers with basic information that is complemented by the studies developed; c) Advancement of scientific knowledge - New discoveries result from combining OGD with own data; d) Information management - OGD become an evidence-based management application, fewer assumptions; e) Improved decision making - described as an effective application for the accuracy of decisions.

Case 04 shows that applying OGD can be useful for organizations like hospitals that while existing in a market environment, have a social function. Other organizations with similar characteristics could follow the example reported here to enhance their managerial practices. In the same industry, other hospitals, even public hospitals, can apply evidence-based management techniques to improve managerial practices and provide better services to the population. One example, highlighted here, is the assessment of emerging medical specialties and techniques to prepare the infrastructure to deal with current and future health demands.

4.3 Discussion of the results

In this section, the research findings are discussed in relation to the consulted literature based on the empirical evidence found. There are subsections to discuss the general results of the OGD-based innovation creation process and the innovation processes in the specific cases.

4.3.1 The OGD-based innovation process

This section contains a discussion of the results found in relation to OGD-based innovation process. To illustrate the results, shows the whole process with each step mapped. It begins with the particular OGD characteristics seen as being necessary in order for them to be of use in creating innovations. Then, the steps identified in the cases are related to those seen as necessary for conditions OGD-based innovation, thus forming a map of the OGD-based innovation process. Finally, the results obtained with the applications are assessed from the point of view of innovation (OECD/Eurostat, 2018).

One of the most frequently mentioned barriers to OGD-based innovation is the poor quality of OGD in Brazil, which in general do not conform to the eight quality principles mentioned in the literature (Gascó-Hernández et al., 2018). The list provides a detailed picture of those barriers in the Brazilian context, which has not yet reached the levels of sophistication found in advanced economies. The generation and dissemination of OGD needs government action to facilitate the process of innovation and policies to foster innovation (Ingrams, 2017). The amount of rework required, due to the poor data quality, in refining, standardizing and adapting the data hampers the development of initiatives, often making them unfeasible. During the study, it was noted the process of opening government data came about to provide transparency rather than opportunities for innovation. This aspect illustrates that governments need to think not only about transparency, but also how data will be used in other initiatives: a demand orientation (Hermanto et al., 2018).

The role of stakeholders in the innovation process was widely mentioned in the literature, but rarely in relation to the contribution of OGD

towards innovation (Kaschesky and Selmi, 2014). The lack of a culture of data openness demonstrates that stakeholders are not yet ready to make effective use of OGD, as suggested by the literature (Sadiq and Indulska, 2017). This study contributes by focusing on how stakeholders should act within the OGD-based innovation ecosystem. The item considered most important for the development of OGD-based innovation is the formation of multidisciplinary teams. Together with data scientists or information technology specialists, professionals with complementary skills are needed to ensure OGD can be transformed into innovations (Gascó-Hernández et al., 2018).

Among the characteristics of OGD-based innovation, one of the most important is the long-term nature of projects (Kaschesky and Selmi, 2014), which considers project maturity. An innovation project will not necessarily provide immediate results, especially if it involves social impacts that are not always the result of a single action. As with other codes that mention the need for quality (Zuiderwijk et al., 2016), the increasing demands for OGD and continuous improvement processes are not very specific in the literature. The generation of new OGD-based ideas and solutions (Weerakkody, et al., 2017) is the primary result of OGD.

4.3.2 Studies of the OGD-based innovation cases

A systematic literature review (Safarov et al., 2017) found only five studies that empirically tested whether OGD can actually generate an innovation. Then, the recognized literature on innovation was consulted, which indicated more specific aspects permeating the innovation process (Väyrynen; Helander and Jalonen, 2023). The first being, how the innovation process starts: applying a new idea or solution to a problem (De Jong and Vermeulen, 2003). Along with this aspect, one can highlight the motivations, because ideas or problems exist anywhere, however, it is motivation that lead to action. Combining new ideas or solutions with motivations constitutes a driver for innovation. There are notable aspects, such as the use of OGD to support decision-making, which is an important practice that demonstrates professionalization (e.g. Cases 2 and 4).

Regarding the barriers to innovation (Baptista et al., 2019) the outstanding item is data quality (Zuiderwijk et al., 2016), which, despite the existence of international data quality principles and the interest in the literature, is deficient in Brazil. Among the resources needed for innovation (OECD/Eurostat, 2018), human resources and the formation of multidisciplinary teams are highlighted, especially with regard to demystifying the role of data scientists, as suggested in Case 2, which mentions a data science team.

Value creation (Smith, 2008; Zuiderwijk et al., 2016) determines whether the results obtained with the applications can considered innovative. In Case 01, enabling social control and participation adds value to the exercise of citizenship. Easy access to data overcomes a barrier in the local context by making the data intelligible. In this situation, there is a structural gain that also generates value by facilitating access to data by the citizen.

Regarding Case 02, several results were listed, particularly the dialogue between public managers, which is facilitated because manipulation of the data identifies social problems that can be solved by multiple agents interacting and cooperating (Kaschesky and Selmi, 2014; Kassen, 2018). Dialogue and cooperation can foster the planning and execution of solutions. Applications that are accessible to the public can lead to advantageous unforeseen uses since when professionals from different areas or citizens with experience in different fields of knowledge use the application, new perspectives may arise. This virtuous cycle can be seen as the main characteristic that makes the system innovative.

In Case 03, the application undergoes a transformation, from the original intended purpose as a tool for social control into a business opportunity. The OGD enabled the creation of a political intelligence system that provides information for decision making, facilitating the management of information from the legislature for decision making (Zuiderwijk et al., 2016). In this specific case, market dynamics comes into play and the OGD are used to assess and manage political and regulatory risk, benefiting organizations in their planning and investments. Such characteristics add value to the corporate market, helping decision makers to identify beforehand those political measures that may affect the business of a specific organization. As the respondents pointed out, it is a relatively new initiative in Brazil that was only made possible with the provision of OGD.

Finally, Case 04 concerns a hospital that uses OGD to modernize its managerial practices and foster scientific research. Unlike the other cases reported here, the result is not an application as such, but rather the ability to explore data to predict demands or challenges. Improved information management is probably the biggest benefit and main innovative feature of OGD. Despite being exclusively for internal use, the OGD has provided new capabilities and support for decision making (Zuiderwijk et al., 2016), which contributes greater accuracy in the hospital management.

The process described is a general map that can be used in future research as a basis for investigating OGD-based innovations. The main difference in relation to other innovation processes is related to the particular features of the OGD ecosystem. The interaction between stakeholders and the purposes for which OGD are generated demands specific conditions that are not common in other innovation processes (Ruijer and Meijer, 2019). Government efforts are essential for the success of the OGD ecosystem (Safarov, 2019) considering its various applications, especially those aimed at innovation (Ingrams, 2017).

5 Final remarks

The interviewees state that the number of OGD-based innovation initiatives is still low in Brazil, as is the amount of OGD available when compared to countries in the developed world. Finally, the authors suggest replicating this study, to find more cases and more variables in order to compose a model that can be applied at a global level. Quantitative research would also be useful to create scales for measuring the process, as it might suggest antecedents, consequents, moderators and/or mediators.

The main challenge will be to find sufficient professionals to answer the questions to enable the creation of scales. One weakness of this study is the low number of variables found. It is hoped the results reported here may inspire other studies to find more variables or to investigate other related research paths, such as the study of barriers, catalysts for the process or the development of a specific method for treating OGD-based innovation.

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