CERTIFICATE OF PARTICIPATION

Rio de Janeiro, 3rd July 2019

This is to certify that **Carolina Yukari Veludo Watanabe** has participated with a paper entitled "**Using Automated Accessibility Metering Tools in Transparency Rankings**" in the 6th Global Conference on Transparency Research held by Getulio Vargas Foundation's schools of Law and Public and Business Administration (FGV-EBAPE and FGV DIREITO RIO) and Columbia Global Centers on the 26th and 27th of June, 2019 at FGV's Rio de Janeiro Campus, on Praia de Botafogo, Rio de Janeiro.

Sincerely,

Gregory Michener
Co-Chair, Global Conference on Transparency Research
Professor, FGV-EBAPE and Principal, FGV Public Transparency Program

Orlando Dantas Street 30 - Room 245
Botafogo - Rio de Janeiro/RJ
22231-010

+55 21 3083 2712
gregory.michener@fgv.br

- 🇬🇧
- 🇧🇷
- 🇪🇸

- [Home](#)
- [Paper Submission](#)
- [Registration](#)
- [The Conference and Videos](#)
- [Local Logistics](#)
- Program and Papers

Program and Papers

Program and Schedule

GCTR 2019 - Final Program

Full Schedule

Submitted Papers

ALBANESE, et al. Building the Glass House

ALMEIDA, F. Transparency, Corporate Governance and Compliance How do Public corporations in Brazil deal

ANDRADE, C et al. Uncertainty in the Figures. A Case Study about Access to Information on Clandestine Mass graves in Mexico

APPELBAUM et al. A Quantifiable Complexity Measure to Evaluate Transparency in Government Financial Data

ARKEDIS et al. Can transparency and accountability programs improve health

ASSUMPÇÃO, A. Electoral Crime Under Democracy

ASSUMPÇÃO, et al. Estimating the Effect of Discreion in Public Spending

BALDO, et al. Using Automated Accessibility Metering Tools in Transparency Rankings

BHARDWAJ, A. JOHRI, A. Evaluating the Performance of Information Commissions in India

BRAGA, S. ANGELI, A. Open Government Data Policies in Latin America

BRANDSMA, G. J. MEJIER, A. Transparency and the speed of multi-actor decision-making process

CAPASSO et al. Fiscal transparency and tax morale

CASAS, P. CHANETON, P. Judicial Transparency and Open Justice: Opportunities and Challenges

CERRILLO-I-MARTÍNEZ. The Evaluation of Compliance of the Transparency Legislation

CHARI, R. CREPAZ, M. Transparency Policy The Public-Private Dimension and Conceptualizing Ecosystems

CHARI, R. CREPAZ, M. Outlining a method of analysis to measure the robustness of transparency policies globally

CHIRAMBO, D. Strategies for Promoting Transparency and Inclusive Growth through South-South Climate Change Cooperation

CICATIELLO et. al. Freedom of Information law at work

CIOCI, F. State-Owned Enterprises - SOEs' Transparency through the lenses

CONTRERAS, P. Changing the bench for a handshake

COSTA, C. Access to Public Information in Brazil, Mexico and Canada

COTA et. al. From freedom of information to public deliberation

CUILLIER, D. Bigger Stick, Better Compliance

DAVENPORT, S. Tax, Transparency, and Trust.

DIAS, V. A experiência do BNDES com a transparência em suas operações

FERGUSON, E. Clear as Water

FILHO, M. Building Transparency the role of the Office of the Comptroller General

FOTI, J. Global Report. Open Government Partnership.

FOUAD, S. Benchmarking

FRANCE et al. Assessing transparency of punitive administrative proceedings in Brazil

FUMEGA, S. SCROLLINI, F. You've got mail the role of digital civil society

GREENWOOD, J. RYNNING, C. Doors, Mirros and Incubators

GREENWOOD, J. RYNNING, C. Transparency, Trilogues and Civil Society Organisations

GUERRIERI et al. The Limits Between Transparency And Professional Secrecy Obligations

Using Automated Accessibility Metering Tools in Transparency Rankings

Franklin Silveira Baldo[1]

Carolina Yukari Veludo Watanabe[2]

Denise Ton Tiussi[3]

SUMMARY: Transparency and the right to information allow social control over public organizations, promoting the fight against corruption and increasing accountability. In Brazil, Law 12527/2011 (LAI) created obligations regarding the minimum form and content to be actively disseminated by public entities. One of LAI's requirements is to use technologies that enable people with disabilities to access the information that has been disclosed. However, LAI did not establish a central body to oversee its implementation, which allowed its implementation to be uneven in the various Brazilian public entities. This gap, in part, has been filled by the rankings of transparency developed by academia and by control entities. These rankings measure the level at which public entities are complying with LAI, comparing them to each other and stimulating the improvement of their scores. However, there are few transparency rankings that included accessibility among its variables. Therefore, this work proposes the use of tools that automate the measurement of accessibility of web pages as a way to facilitate the measurement of the accessibility of transparency portals and their inclusion as a variable in transparency rankings. Finally, we demonstrate the use of the proposed method by reconstructing transparency rankings with the inclusion of the accessibility variable measured through the Lighthouse tool developed by Google.

KEYWORDS: Transparency, ranking, accessibility, measurement.

1 Introduction

Increasing government transparency and guaranteeing access to information for citizens are ways to reduce the asymmetry of information in the relationship between representative and represented. This reduction in the asymmetry of information increases the citizens' ability to act and facilitates the alignment of the representatives' personal interest with the public interest (Stiglitz, 1999).

In Brazil, Law 11,527 / 2011, also known as the Law on Access to Information (LAI), obliged government entities to maintain websites to disseminate a minimum of information on the finances and functioning of these public bodies.

---

[1] Bachelor in Law from the Universidade Federal de Rondônia (UNIR); masters student at Universidade Federal de Rondônia (PPGMAD/UNIR). Email: franklinbaldo@gmail.com.

[2] Post-doctorate student in Business Admnistration at EAESP-FGV. PhD in Computer Science and Computational Mathematics from the Instituto de Ciências Matemáticas e de Computação (ICMC-USP). Teacher at PPGMAD/UNIR. Email: carolina@unir.br.

[3] Master in Business Administration from the Federal University of Rondônia (UNIR). Bachelor in Economics from the Federal University of Paraná (UFPR). Teacher at the Federal Institute of Rondônia (IFRO)

In addition to the content, the LAI also defined criteria for the presentation of data to be disseminated and one of them is the application of accessibility technologies that enable its use by people with disabilities (Brazil, 2011, art 8o, §3o, VIII).

However, the absence of a central body responsible for overseeing the implementation of LAI is often pointed out as a challenge to its effectiveness (Michener et al., 2018). Without supervision, public entities tend to postpone their implementation.

The disclosure of transparency rankings can fill some of this gap and stimulate more stringent compliance with the law. Rankings are instruments to raise public awareness to regional problems, stimulate discussion on strategies to improve indicators, being an important set of tools to stimulate the competition between cities towards a specific public policy (Giffinger, Haindlmaier, & Kramar, 2010) .

The dissemination of a ranking ignites a learning process in public opinion to determine if their city holds an appropriate position in the ranking, stimulating public managers to make more transparent decisions in actions that impact the indicators of this ranking.

In this way, rankings can play an important role in stimulating the increase of government transparency in Brazil. In that sense, some rankings have been created to measure the transparency in Brazilian municipalities, two of which will be described below due to their relevance. The National Transparency Ranking was elaborated by the Federal Prosecution Service, it had two editions in which it evaluated the active transparency in 5,568 prefectures and 27 states of the Brazilian federation (Ministério Público Federal, 2015).

The Brazilian Transparency Scale indicator of the Office of the Comptroller General is a highlight in the scope of passive transparency. In three editions, this survey evaluated state capitals and a random sample of municipalities by sending requests for access to information and measuring their response rate, response time, and completeness of response (Controladoria Geral da União, 2019) .

Klein and Freire (2017) have compared the items evaluated in these two rankings with the legal requirements imposed by the Brazilian transparency legislation and found, among other findings, that they did not evaluate compliance with the obligation to keep portals accessible to people with disabilities.

Not including the variable accessibility prevents mapping the accessibility level of government sites and reduces the ability of these rankings to stimulate the improvement of transparency in a broader way. After all, the accessibility of government websites is key to enabling the full and effective participation of people with disabilities in society.

Web accessibility assessment is an extremely technical task that depends on the analysis of the source code of the visit page and its suitability for technical reference standards used by the technological devices being utilized. Because of its specificity, the accessibility assessment by humans is the only way to determine if a page meets all technical standards (W3C WAI, n.d.), but time and resource constraints ultimately prevent this method from being feasible for the elaboration of transparency rankings where hundreds or thousands of pages should be assessed.

On the other hand, automatic tools for accessibility assessment can quickly identify accessibility issues through fully automated scans or help with manual reviews (W3C WAI, n.d.). Thus, the use of computational tools to aid in the evaluation of accessibility of websites can facilitate the inclusion of this indicator in transparency rankings and map the level of accessibility of government sites.

Although it is not entirely clear why accessibility was not assessed in these rankings, previous studies have pointed to a lack of knowledge of the existence of automated accessibility assessment tools as one of the reasons for low levels of accessibility (Tangarife & Mont'Alvão, 2005). In parallel, these tools may also not be known by the creators of transparency indicators.

Thus, in this article is propose a method to generate batch evaluation of the accessibility of websites, so that this evaluation can be used in the transparency rankings. For this will be discuss the normative framework about accessibility on the web, especially on transparency sites and will be presented tools that can automatically verify if these standards are being fulfilled by a certain website. Finally, will be show how the use of this tool can allow the inclusion of the accessibility variable in transparency evaluation rankings.

2 Theoretical reference

The term transparency refers to an emerging value in the world which determines that the authorities have a duty to make information available and that the public and citizens have the right to access this information (Holzner, 2007).

The rise of transparency at the global level is associated with the development of theories that predict its basic function of reducing agency problems (Mitnick, 2015) in the public sector and consequently increasing the accountability of governments (Stiglitz, 1999).

That is, the importance of transparency derives from its ability to enable the public to make better informed decisions.

One of the manifestations of this phenomenon in Brazil was the edition of Law 12,527 of November 18, 2011 (Brazil, 2011), known as the Law on Access to Information (LAI), considered by many as a firm step towards transparency (Flores, 2012).

This law has been an advance in both passive transparency, which depends on the request of the citizen, since it has set deadlines and competences for the fulfillment of these requests, as well as in the scope of active transparency, which should occur independently of request, obliging entities to maintain a website and a detailed index of the content to be published.

However, institutional barriers may hamper the implementation of LAI, compromising its effectiveness as a tool to combat corruption and social control. The lack of effectiveness in laws on access to information is a well-known phenomenon precisely because they seek to legislate against the existing culture of secrecy in government bodies, which can be extremely difficult when it lacks the appropriate remedies for its application (Stewart, 2010).

The lack of a central body that supervises and enforces the law has already been pointed out as one of the shortcomings of LAI (Michener et al., 2018) and also as a possible cause of its unequal implementation in the various Brazilian governmental entities (Flores, 2012).

Beyond the formal mechanisms of coercion, there are other factors that can contribute to the success of laws on access to information such as the media and political competition (Michener, 2011).

But the public managers' perception is that there is little social pressure to disclose information and consequently for the implementation of the Law on Access to Information (Morais, Teixeira, Morais, & Teixeira, 2016).

It remains clear that social pressure is essential to promote government transparency, but public managers - responsible for implementing LAI in practice - do not feel this social pressure, creating a framework conducive to maintaining the status quo.

Thus, will be discussed the role of LAI implementation in improving government transparency in Brazil, and then see how transparency rankings can catalyze this implementation.

2.1 The use of rankings to encourage transparency

The Law on Access to Information established a series of obligations that would lead to increased public transparency in Brazil if widely adopted. But for this to happen it is necessary that there is effective compliance with the law in the various subnational units (states and municipalities) and their respective agencies.

The process of implementing LAI by seeking to make public bodies more similar with respect to transparency, falls within the concept of isomorphism. According to DiMaggio and Powell (1983) isomorphism manifests itself in three forms: (i) coercive, in which the imposition of force of another organization on others causes these to become similar; (ii) mimetic , when a voluntary organization adopts practices adopted by others; and (iii) normative , derived from the professionalization of personnel, which by the uniformity of their experience, tend to influence organizations in a similar way.

Because it was a law created by the Brazilian federal government, it was to be expected that the process of LAI implementation would occur mainly through coercive mechanisms. However, the absence of a central body with authority to oversee this implementation has transferred responsibility for inspection to other non-coercive actors such as civil society, researchers, and nongovernmental entities. But these actors have a limited set of tools to exert their influence which makes other forms of isomorphism (mimetic and normative) more relevant in this process.

A process that adds the characteristics of mimetic and normative, and sometimes coercive, isomorphism is benchmarking. Benchmarking is the process of measuring the products, services, and practices of an organization by comparing with others who are recognized leaders in their industry (Camp & Camp Robert, 1989). In public organizations, benchmarking can facilitate performance management by spreading good practices to improve indicators towards the group average (Gerrish & Spreen, 2017).

Traditionally benchmarking starts from an internal initiative of the organization seeking to improve its performance, a process that resembles mimetic isomorphism (Heeks, 2008). On the other hand, because of its sophistication, benchmarking is not always a practice adopted in local governments. In these cases, the organizational will to adopt the best practices does not gain practical outlines due to lack of information.

In other situations, benchmarking may be the result of studies carried out by external actors, resulting in a simultaneous process of mimetic and coercive isomorphism.

In these cases, it can be said that the donation of benchmarking tools occurs, such as rankings that can help the receiving organization to make internal changes, making it more competitive (Kromidha, 2012). This donation occurs, for example, when the organization is evaluated in the context of a ranking by an external institution (Kromidha, 2012).

The donation of benchmarking tools, while not eliminating the need for internal learning (Kromidha, 2012), assists governments to make retrospective evaluations comparing the past

performance of their institutions and also making decisions about priorities and directions for the process of technological development (Heeks, 2008).

It is very common to use composite indicators (or indexes) in the process of benchmarking countries. The composite indicators are formed by individual indicators aggregated according to a model of the multidimensional concept being measured (Freudenberg, 2003).

In this process, composite indicators are valuable because they manage to integrate a large amount of information into a format easily understood by the general public (Freudenberg, 2003).

International organizations such as the Organization for Economic Co-operation and Development (OECD) produce a wide range of composite indicators with the aim of ranking countries according to a concept. Therefore, the improvement in the construction of these indicators is an important research question (Munda & Nardo, 2003).

One example in the field of transparency is the Corruption Perception Index created by Transparency International in which countries are ranked by a composite indicator that represents the perception of corruption (Transparency International, 2018).

The composite transparency indicators that evaluate Brazilian municipalities and states play a similar role to the indicators produced by international institutions, with the difference that the evaluation unit is not a country, but states and municipalities. But they also allow the occurrence of a benchmarking process within the subnational entities compared.

2.2 The relationship between transparency and accessibility

The composite transparency indicators used in Brazil commonly use the criteria defined in the LAI to determine individual indicators. These individual indicators are then aggregated into a composite indicator of transparency that is used for the ranking of the government entities evaluated. LAI therefore functions as a model for the creation of transparency indicators. And its use is in line with studies that recognize the importance of LAI for advancing transparency in Brazil (Michener, 2011).

Accessibility is one of the criteria defined by LAI in this context and must be obeyed by public entities. LAI expressly provides that sites maintained by public bodies must be accessible to people with disabilities (Brazil, 2011, art. 8o, §3o, VIII). The LAI also refers to other norms that determine the accessibility of public services such as Law 10,098/2000 (Brazil, 2000) and Legislative Decree nº 186/2008 (Brazil, 2008).

Although it is linked to transparency, accessibility is important not only in this context but also for all public services. The law recognizes the need to ensure accessibility for people with disabilities to exercise all their rights.

Once the relationship between accessibility and transparency is determined, it is necessary to clearly define the concept of accessibility, since a robust theoretical framework is the starting point for the construction of composite indicators.

2.3 What is accessibility?

Accessibility refers to the design feature that enables people with disabilities to interact with objects, services or products (Henry, Abou-Zahra, & Brewer, 2014).

The Convention on the Rights of Persons with Disabilities claims that accessibility is important in enabling people with disabilities to the full enjoyment of all human rights and

fundamental freedoms, to live independently and to participate fully in all aspects of life (United Nations, 2006).

According to the Brazilian Inclusion Act, a person with disability is

> someone that has a long-term physical, mental, intellectual or sensorial disability, which, in interaction with one or more barriers, may obstruct their full and effective participation in society on an equal basis with other people (Brazil, 2015).

According to W3C Brasil (W3C Brasil, 2018), the Brazilian branch of the international body dedicated to promote accessibility on the web, the definition of person with disability in the Brazilian Inclusion Act is based on three characteristics:

> The first is that the impediment is long-term, so that the solution of the resulting problems cannot be postponed or provisionally circumvented. Therefore it calls for a permanent, sustainable and definitive solution;

> The second characteristic is that the impediment is not evaluated in isolation, but in the interaction with one or more barriers of the environment. This means that the same deficiency can be very severe, or not be obvious. It will depend on the conditions the person lives in, the accessibility of their environment and the behavior of the individuals that constitute the society in which they are inserted.

> The third characteristic is that the criterion of equalization is no longer the standard of physical health, relative to the survival and safety of the person with disability but begins to consider their full and effective participation in society on an equal basis with other people. (W3C Brasil, n.d.)

Once the concept is defined it is important to establish some distinctions: accessibility is not the same as usability. Usability is the characteristic of the service or product that is effective, efficient and satisfactory, but its focus is on people with special needs such as accessibility. Usability and accessibility do relate, and in many cases the development of accessibility technologies has brought benefits to the general public. One example is assistive technology designed to give people with low vision access to the web and who have inspired the technology that allows devices with small screens, such as smartphones, to properly display page content. But it is important to continue to enforce the term accessibility to people with disabilities to ensure that those people's needs are met and not be lost in a larger discussion (Henry et al., 2014).

The Law on Access to Information also created criteria for the usability of government websites such as containing a search tool, use of easy-to-understand language, possibility of recording reports, use of open formats, possibility of automated access, dissemination of information structure , guarantee of authenticity, integrity and timeliness of data (Brazil, 2011, art. 8o, §3o). But given the distinction between usability and accessibility, these criteria are beyond the scope of this work.

Thus, the strive for accessibility on the web consists mainly of care to be taken from the design process, to the development and edition of websites with the goal of enabling equal access to information and functionality to all users regardless of their deficiencies.

An example is the care to provide alternative texts to the images displayed in the HTML code, helping blind readers to understand their meaning.

In this process, the harmonization of the techniques to be used in the production of content is essential to ensure a consistent operation of the available technologies.

2.4 Accessibility assessment in transparency rankings

In the absence of a central body to oversee the implementation of LAI, rankings based on composite indicators have played an important role in improving levels of transparency in Brazil. Some of these rankings operate at the regional level, and a few at the national level. Among the rankings with national coverage, two are notable for their repercussion: the National Transparency Ranking (Ministério Público Federal, 2015) and the Transparent Brazil Scale (Controladoria Geral da União, 2019)

The National Transparency Ranking was prepared by the Federal Prosecution Service and evaluated the active transparency of 5,568 prefectures and 27 states. This survey assessed whether city hall and state governments met certain legal requirements regarding active transparency. Two editions were made: the first occurred between 09/08/2015 and 10/09/2015 with disclosure on 12/09/2015. In the second edition the data were collected between 04/11/2016 to 05/27/2016. The data of the evaluations carried out by the National Transparency Ranking are available on the website of the Federal Prosecution Service.

The Transparent Brazil Scale is a survey on the level of passive transparency of prefectures and state governments conducted by the General Comptroller's Office (CGU). Three editions have already been made, but not all municipalities are evaluated, only the capitals of each state plus a random sample of the other municipalities. All data is available on the website of the project (Controladoria Geral da União, 2019).

It turns out that a survey comparing these and other composite transparency indicators with legal obligations from the LAI found that none of these indicators included the assessment of accessibility (KLEIN & FREIRE, 2017).

There are, however, indicators in which the methodology used includes accessibility assessments, but often accessibility is defined broadly and conceptually blended with the concept of usability. An example of it is the Transparency Index of Public Administration (ITP) developed by the Court of Auditors of the State of Paraná (Tribunal de Contas do Estado do Paraná, 2019). Developed by the Court of Auditors of the State of Paraná in order to evaluate transparency in public bodies, ITP's assessment instrument has a specific accessibility section where topics related to accessibility (screen contrast, shortcut keys) are grouped with other usability related items (FAQ and search tools).

Thus, in the scope of the transparency indicators in Brazil, accessibility is often overlooked or used in a less precise way. Therefore, it is important to establish parameters for the inclusion of the accessibility variable in transparency indicators.

A starting point in this direction is the construction of composite indices taking into account globally recognized parameters, such as those established by the OECD (OECD, 2008).

In its recommendations for the construction of composite indicators the OECD recommends that the selection of individual indicators should seek to maximize the quality of the final result, and for this it is necessary to analyze whether this indicator has the following characteristics: relevance, accuracy, punctuality, accessibility, interpretability and coherence (OECD, 2008). Such characteristics are conceptualized and summarized in Table 1.

Table 1 - Quality dimensions of composite indicator variables

Dimension	Concept
Relevance	Qualitative analysis derived from the theoretical framework that determines if the variable contributes to the desired result.
Accuracy	The degree to which the variable correctly estimates or describes what it was designed to measure.
Punctuality	Time gap between the availability of the data and the occurrence of the phenomenon that it describes
Accessibility	The degree to which data can be readily located and accessed from its original sources
Interpretability	The ease of the user to understand, utilize and analyze the data correctly.
Coherence	The degree to which data is logically connected and mutually consistent. For example, the data must maintain its coherence over time and between different subjects

Source: prepared by the authors based on OECD recommendations (OECD, 2008).

The weight of indicators can have a significant effect on rankings. There are many techniques for assigning weights, some based exclusively on statistics and others based on expert opinion but, regardless of the method, weights are in essence value judgments (OECD, 2008).

Each method has its pros and cons that must be considered by the author of the ranking. The choice of weights ultimately depends on the purpose and characteristics of the indicator to be constructed.

It is not in the scope of this publication to discuss how much weight should be given to accessibility in the elaboration of transparency rankings, therefore, it is recommended that this process be carried out considering processes that have a backup in literature. However, the weight allocation process can be facilitated by the use of algorithms that facilitate the application of the OECD recommendations, such as Compind software (Vidoli & Fusco, 2018).

Therefore, the development of a method for collecting web accessibility data can contribute to the overall quality of composite transparency indicators.

2.5 The choice of the standard of accessibility norms

Several technical standards have been created around the world to ensure accessibility, the most widely used is the Web Content Accessibility Guidelines (WCAG) developed by the World Wide Web Consortium (W3C).

WCAG enlists a set of recommendations looking to make web content more accessible to people with disabilities, including blindness and low vision, deafness and low hearing, learning disabilities, cognitive limitations, movement limitations, speech disability and photosensitivity and the general users.

The W3C is an international organization comprised of over 400 companies, government agencies and independent organizations and led by Tim Berners-Lee, the inventor of the web ("Tim Berners-Lee," 2019). W3C seeks to establish standards for the creation and interpretation of web content and its members include technology giants like Google, Facebook and Mozilla ("Current Members - W3C," n.d.).

The W3C includes among its principles the development of the web for everyone, regardless of the hardware they use, software, network infrastructure, language, culture, geographical location or physical and mental capacity ("W3C Mission," nd) , and has a workgroup dedicated to accessibility called the Web Accessibility Initiative (WAI).

Published in June 2018, WCAG 2.1 is the most current version of the accessibility guidelines created by the W3C and was written in the form of a group of testable statements that are not targeted to a specific technology.

WAI also approved the Accessible Rich Internet Applications (WAI-ARIA) protocol, which is a set of rules designed to allow the web developer to indicate the behavior and informational structure of the page, aiding the operation of special accessibility tools, such as Braille readers.

WAI-ARIA standards do not change page behavior or appearance for users who do not use these special technologies, but their misuse can lead to malfunction, making the page completely inaccessible.

2.6 The Accessibility Model in Electronic Government

According to the Brazilian Inclusion Act, government entities and companies must adopt the best practices and accessibility guidelines adopted globally (Brazil, 2015).

But before the Brazilian Inclusion Act was published, there was already an accessibility standard created by the federal government: the eMAG - Accessibility Model in Electronic Government ("eMAG - Modelo de Acessibilidade em Governo Eletrônico," n.d.) .

There is notable contradiction since the law determines the adoption of international standards and the federal government uses a specific standard for Brazil. But this contradiction is only apparent, because eMAG is based on WCAG to make recommendations to Brazilian government sites, but does not exclude any good practices recommended by the W3C ("eMAG - Modelo de Acessibilidade em Governo Eletrônico," n.d.). Therefore, evaluations parameterized by WCAG will also cover most eMAG requirements.

For the elaboration of an accessibility indicator in an automated way it is essential to have good tools at one's disposal. So, it is important to note that there is few software that make the verification of compliance with the eMAG model. In a search for tools that are compatible with eMAG only two were found: the Site Accessibility Simulator and Evaluator (ASES), developed by the federal government itself (Ministério do Planejamento, n.d.), and also DaSilva ("Sobre o Avaliador," n.d.)

It is also important to note that surveys comparing eMAG and WCAG concluded that the Brazilian model did not "fully follow all W3C recommendations" (Tangarife & Mont'Alvão, 2005) and that "the recommendations proposed by the two standards have few differences, indicating that the international standard is suited to the national needs" (Bach, Leal, Silveira, & Nunes, 2009).

In summary, eMAG was specifically designed to be applied to federal government websites and prioritizes the application of certain specific rules of the WCAG but does not preclude the application of international standards. Therefore, evaluating the accessibility of government portals based solely on eMAG does not meet the provisions of the Brazilian Inclusion Act.

For these reasons, it is concluded that in the context of accessibility assessments to produce a ranking of city halls it is recommended the adoption of the standards developed by the W3C as a reference.

3 Methodology

This present research has a quantitative approach due to the nature of the data to be collected. The design of the research is descriptive, since the phenomenon was observed, described and documented. The results of descriptive research create a knowledge base that will guide the hypotheses of subsequent studies.

The research has a transversal cut because the data collected represents reality from a certain point in time. As for the procedures, this is a field survey since the data were collected directly from the phenomenon.

Fig. 1 represents the assessment workflow for the evaluation of the websites of city halls of all 5,570 Brazilian municipalities and will be addressed in further detail in the following sections.

Figure 1 - Pipeline of the proposed method
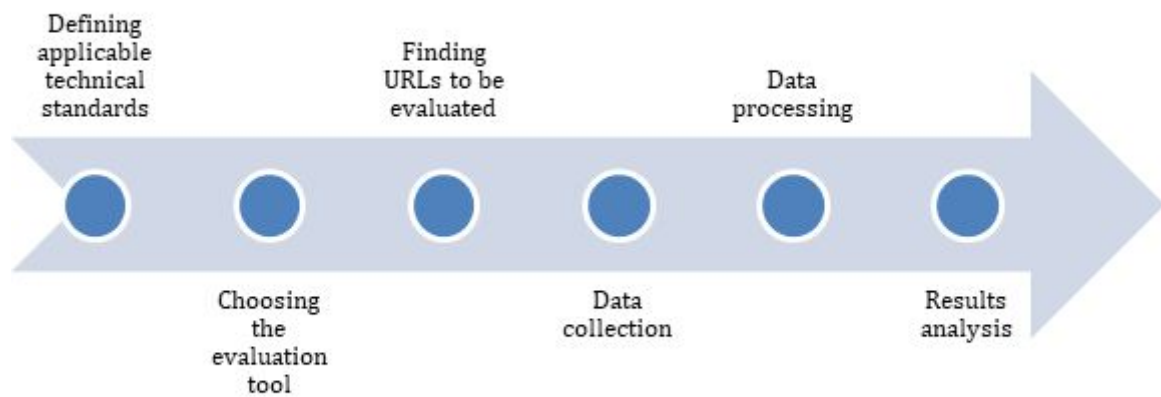
Source: Elaborated by the authors.

3.1 Population and Sample

In order to demonstrate the proposed method, an accessibility assessment of municipalities was carried out in Brazilian municipalities. The sample has a census character as it evaluated the accessibility in the websites of all the 5,570 Brazilian municipalities.

A website usually consists of several pages, so it is important to define which ones are evaluated because time and resource constraints make it infeasible to measure accessibility of all hosted pages for ranking purposes. Following in the footsteps of previous research (Sullivan & Matson, 2000) only the main page of each city hall website was evaluate, as this is the user's gateway to the content subordinated to it. Accessibility issues on the home page are more critical because they can prevent access to other pages that do not have the same accessibility problem.

In the course of the research it was observed that some municipalities do not have a website, but they have a specific page for disclosure of the mandatory disclosure information specified in the Access to Information Act. Generally, these pages are hosted on the websites of state government, municipal associations or specialized companies.

It is important to note that finding all the addresses of the sites to be evaluated was a laborious process, since no repository was found with all the electronic addresses of all Brazilian city halls. Even the National Transparency Ranking that evaluated all municipalities in Brazil, did not tabulate the electronic addresses used to carry out the evaluation.

Thus, a previous step to generate a list of all Brazilian city halls' electronic addresses was necessary. This list was generated in adherence to the following procedures for each municipality:

1) Establish a web address following the standard recommended by the CGU (CGU, 2013): name of the municipality followed by a dot, followed by the state acronym, followed by a period and finally the expression 'gov.br ', for example municipalityname.sa.gov.br.

2) Attempt to access the address defined in step 1 and the alternative that includes the subdomain "www". If access was successful, this address was defined as the web address of that city hall.

3) In the cases where there was an access error in step 2, a search was done in the Google search engine to try to find the official site of the city hall. If the mentioned site was found and the access was successful, this address was defined as the web address of that city hall.

4) In the cases where the official website of the city hall was not found, but a page was found for disclosure of transparency hosted by the government of that state or by municipality association, it was considered the official page of the municipality.

3.2 Tools used for assessment

As discussed previously, the accessibility assessment on sites of Brazilian municipalities should have as criteria the technical standards established by the W3C. Once the set of rules to assess transparency has been defined, one must choose the appropriate tool to check the application of these norms.

The W3C maintains a catalog of about 123 web accessibility evaluation tools ("Web Accessibility Evaluation Tools List," n.d.) detailing the capabilities and characteristics of each. From this list, only the tools with open source license and with programming interface (API) for command line were selected. Such characteristics allow the accessibility assessment to be carried out in batches and without human intervention, allowing the survey to be done in many web addresses in a short time, as initially proposed.

Only two tools gathered the correct characteristics to remain on the list: Pa11y ("Pa11y," n.d.), axe-core (Deque Labs, 2015/2019) .

Of these two tools, the axe-core has a great advantage for comparability of the results because it has been integrated with the Lighthouse web page auditing software, which in turn was adopted by HTTP Archive as the standard tool for data collection ("HTTP Archive FAQ," n.d.).

Lighthouse is an open-source, free software developed and maintained by Google to run a series of tests on web pages generating a performance report. Lighthouse's accessibility tests are performed through the axe-core ("Google Selects Deque's axe for Chrome DevTools," 2017).

HTTP Archive is an organization that collects and publishes historical performance data on more than 4 million websites from some of the most popular ones. HTTP Archive aims to provide data for researchers and quantitatively illustrate the evolution of the web. Among the data collected, there are accessibility assessments using Lighthouse ("About HTTP Archive," n.d.).

The report generated by Lighthouse contains the list of accessibility errors found on the page and a general note for page accessibility in the range of 0 to 1. The list of completed checks and weight are detailed on the project's page (Google Developers, n.d.).

A weighted final grade is given and that allows this note to be directly used in the elaboration of the transparency indicator, removing the responsibility of assigning weights from the indicator's owner, especially when accessibility is not the central theme evaluated. It also permits that the results remain comparable to other evaluations performed with the same tool.

On the other hand, the detailed report indicating the results of each check provides information that helps those responsible for the evaluated sites to understand the reason for the assigned note and to correct the errors found.

Due to the possibility of comparing the results of this research with the historical series of HTTP Archive, the accessibility note attributed by Lighthouse as an indicator of accessibility in the evaluated web pages will be adopted in the present work.

3.3 Accessibility data collection

The assessment of the accessibility of a web page can be done through Lighthouse in two ways: using the extension for the Chrome browser or using the command line interface (CLI). In either way the same reports can be generated, with the choice of method being dependent on an assessment of practicality.

Usually, in the elaboration of transparency rankings, the researcher will access the web page of the governmental institution to verify the presence of the obligatory items filling a proper form. The assessment made by extension allows transparency information to be collected at the same time so that the final note assigned by Lighthouse can feed one of the questions in the form. The generated report can be saved for any queries. Despite its practicality, this approach has the disadvantage of consuming the researcher's time because he needs to wait for Lighthouse to do the evaluations.

In the assessment through the command line interface, it is necessary to previously obtain the list of addresses to be accessed (URL). This list can then be used to create a command for Lighthouse to evaluate all addresses automatically, without further human interference. In this approach, a later step of extracting and consolidating the results from the report saved by Lighthouse is required, but these procedures can also be automated, as will be demonstrated in the next section.

3.4 Data consolidation

Once the accessibility data is collected, consolidation is required as Lighthouse stores each report separately. At this stage, the pandas library (McKinney, 2010) was used, resulting in a table relating the evaluated portal address and the results of the accessibility tests.

Table 2 - Summary of methodological procedures

Procedure	Tools used
1 - Elaboration of the list of URLs to be evaluated	Table with names and state acronyms of all municipalities, Google (search engine)
2 - Collection of accessibility data	Lighthouse (by command line)
3 - Data tabulation	IPython, Pandas

Source: prepared by the authors

3.5 Analysis of the results

Once consolidated, accessibility results will be analyzed through comparisons with other municipalities′ numbers, regarding, for example, geographic, social and economic indicators, as well as transparency indicators of the National Transparency Ranking.

The results will also be compared against the web accessibility report provided by HTTP Archive (HTTP Archive, n.d.) .

Finally, the general quality of the accessibility variable supported by the quality standards established by the OECD (Table 1) will be scrutinized in order to analyze the possibility of including accessibility data produced under this article in a composite indicator of transparency.

4 Results

Data collection was performed between 27.04.2019 and 17.05.2019, and the results are presented below.

4.1 Elaboration of the list of URLs to be evaluated

Following the procedures described in the methodology, it was attempted to directly access the websites of the city halls following the pattern of indicated domain names. This technique made it possible to access 5,070 out of a total of 5,570 municipalities. In the remaining municipalities (n = 500), it was necessary to search the city hall′s URL in search engines.

Even utilizing search engines, the URL from the city′s official website was not found for the municipalities listed in Table 3. The complete list of URLs of Brazilian city halls was published on the Github platform in order to support future research (Baldo, 2019/2019).

Table 3 - City Halls with no official web page

IBGE code	State	Municipality
1200344	AC	Manoel Urbano
2705606	AL	Novo Lino
1300805	AM	Borba
1303007	AM	Nhamundá
3130556	MG	Imbé de Minas
3160454	MG	Santo Antônio do Retiro
3164506	MG	São Sebastião do Maranhão
3170305	MG	Umburatiba
2206902	PI	Novo Oriente do Piauí

2406601	RN	Lagoa Salgada

Source: prepared by the authors

4.2 Collection of accessibility data and data tabulation

In the following stage, from the URL list, the accessibility data was collected using the Lighthouse software in the command line mode, saving the report generated in files in Json format (Google Developers, n.d.).

At this stage, Lighthouse was not able to generate the report for some sites even after the revision of the URL (n = 9).

The reports were then read and tabulated using an IPython notebook (Perez & Granger, 2007) and the Pandas library (McKinney & Team, 2015). The accessibility note assigned by Lighthouse was registered on a scale of 0 to 1.

4.3 Descriptive statistics analysis

The dataset produced describes the web accessibility of Brazilian municipalities and its distribution is represented as a histogram in Figure 2.

Figure 2 - Histogram of web accessibility of Brazilian municipalities
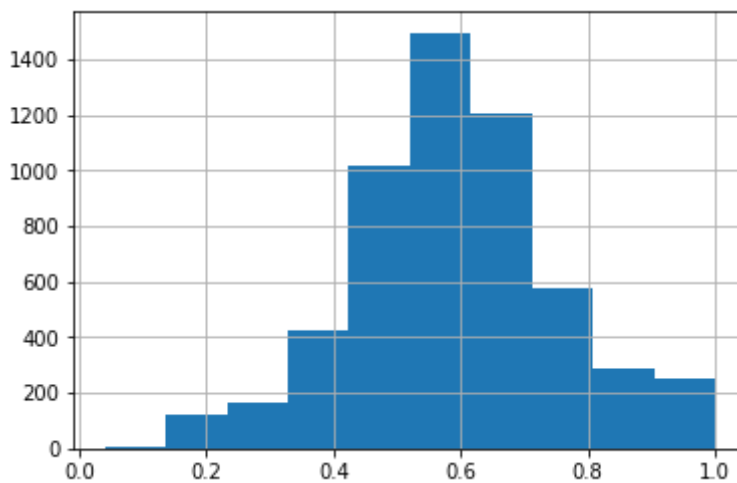
Source: prepared by the authors

Analyzing the distribution of the data points of this data set one can see a central tendency slightly skewed to the right. The standard deviation was 0.1639. The median of web accessibility of municipalities was calculated as 0.59. This value is below the median calculated by the Http Archive for 01.04.2019, which was 0.64 (HTTP Archive, n.d.).

Table 4 presents a comparison of the web accessibility of the Brazilian municipalities with the general accessibility of the Web according to the data provided by the HTTP Archive in several percentiles of the data set.

Table 4 - Distribution of accessibility in municipalities by percentiles compared to HTTP Archive

Set of data	p10	p25	p50	p75	p90
Brazilian municipalities	0.39	0.48	0.59	0.69	0.80
Http Archive (2019-04-01)	0.44	0.53	0.64	0.74	0.84

Source: prepared by the authors from search data and HTTP Archive (HTTP Archive, n.d.)

These results indicate that there is a great opportunity for improvement of the web accessibility of the municipalities of Brazil, because in all percentiles the values found for municipalities are below the values seen in the HTTP Archive.

It should be remembered that, unlike the web pages of the municipalities, the internet pages in general do not have a legal obligation to meet accessibility criteria, which makes even more worrisome the finding that the pages of Brazilian city halls are less accessible than the sites evaluated by HTTP Archive.

Finally, Pearson's coefficient of correlation was calculated between the web accessibility of municipalities and demographic and economic indicators of the municipalities coming from the "Profile of the Brazilian Municipalities" (IBGE, 2015), from the Atlas of Human Development in Brazil ("Sobre o Atlas," n.d.) and from the National Transparency Ranking (Ministério Público Federal, 2015), but no significant correlation was found.

4.4 Accessibility Maps

To give an overview of the spatial distribution of accessibility levels across the country, we used the Geopandas library and IBGE geometric data to plot the data collected over the Brazilian territory, as shown in Figure 3.
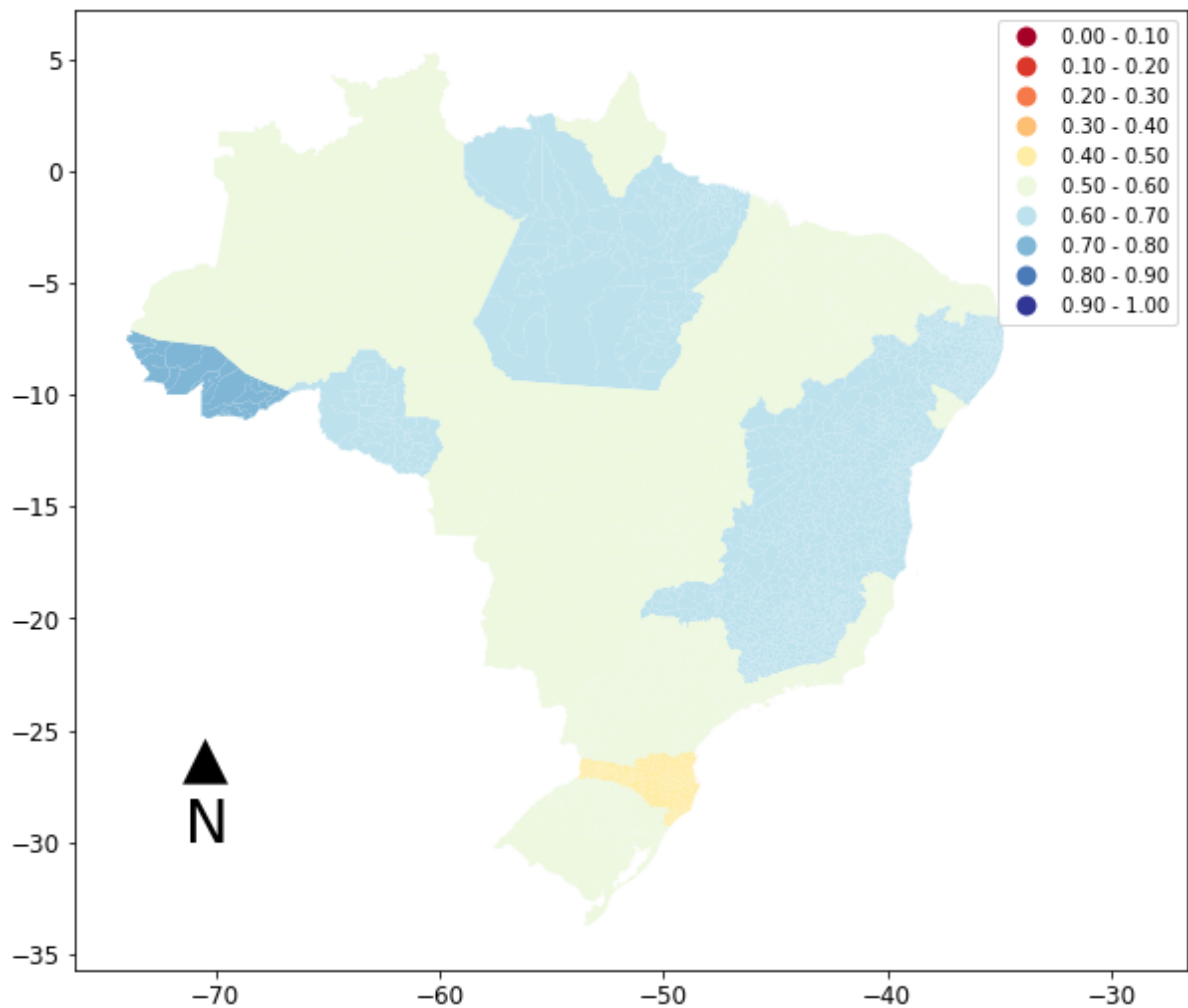
Figure 3 - Web accessibility of city halls by municipality
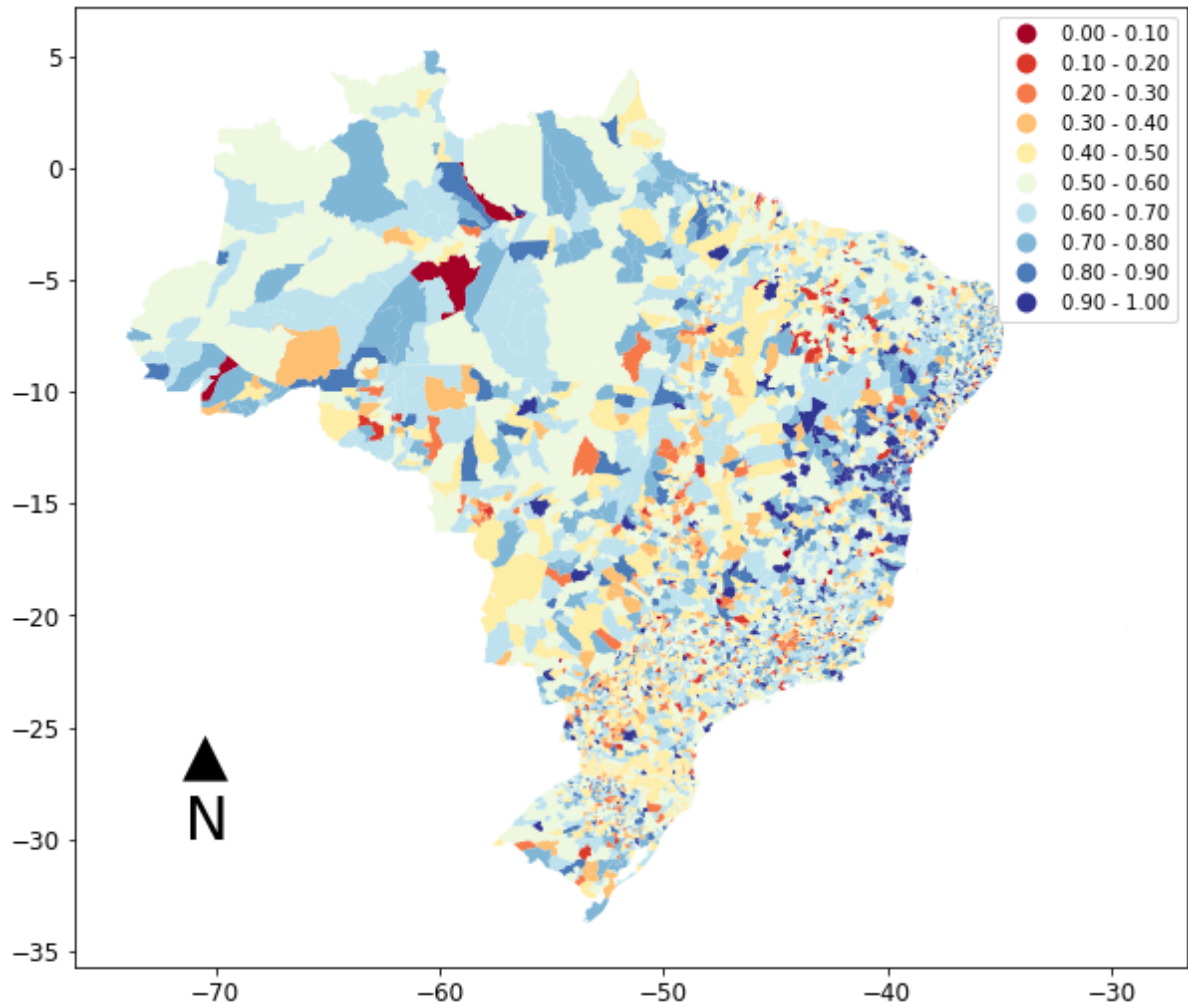
Source: prepared by the authors

From reading the map shown in Figure 3, it is not possible to identify clear trends. Thus, the results were grouped by state represented by the median of the scores of their municipalities, according to Figure 4.

Figure 4 - Web accessibility of city halls by state (median)

Source: prepared by the authors

Analyzing the data in Figure 4, there is a great homogeneity in accessibility in Brazil, the one highlight being the state of Acre that had the best result, with a median of 0.705, and Santa Catarina the worst result with a 0.48 median.

4.5 Quality of data obtained for use in composite transparency indicators

Given the set of data obtained, it can be observed that the accessibility data collected in this research sufficiently fulfills the individual variable quality criteria to integrate a composite indicator of transparency. The evaluation considered the OECD criteria (OECD, 2008) and the finding were summarized in Table 5.

Table 5 - Assessment of the quality of web accessibility as an individual indicator of a composite transparency indicator

Dimension	Concept	Assessment
Relevance	Qualitative analysis derived from the theoretical framework that determines if the variable contributes to the desired result.	Affirmative. As discussed in the theoretical framework, accessibility is part of transparency so that everyone can fully enjoy the right to information.
Accuracy	The degree to which the variable correctly estimates or describes what it was designed to measure.	The method of data collection used is based on the best technical standards available.
Punctuality	Time gap between the availability of the data and the occurrence of the phenomenon that it describes	Immediate.
Accessibility	The degree to which data can be readily located and accessed from its original sources	Immediate.
Interpretability	The ease of the user to understand, utilize and analyze the data correctly.	Affirmative, because the data is presented in a range of 0 to 1 and are supported by details that allow the user to understand the assigned note.
Coherence	The degree to which data is logically connected and mutually consistent. For example, the data must maintain its coherence over time and between different subjects	Affirmative, according to the researched literature, automated accessibility assessments are consistent and are being massively used

Source: prepared by the authors

5 Conclusion

This study proposed to present a method to measure the accessibility of government portals in an efficient and fast way. The results obtained indicate the success of this endeavor. The characteristics of the collected data set allow us to affirm that they can be used in the elaboration of transparency rankings.

In turn, the dissemination of transparency rankings that include accessibility indicators, through stimulating competition and facilitating the benchmarking process, can reduce access barriers for people with disabilities to the government pages that were evaluated.

In fact, the results indicate the existence of opportunities to improve the level of web accessibility of Brazilian municipalities and the possibility of enhancing this process with the inclusion of accessibility in composite indicators of transparency.

The results of this study outline, for the first time, an overview of web accessibility in Brazil's municipalities. This is a great achievement and can yield even better results if the study is replicated, because this will allow the analysis of tendencies in the accessibility field.

This study also contributed to the improvement of the quality of transparency indicators, providing a detailed theoretical framework on the relationship between accessibility and transparency, as well as the importance of measuring these concepts.

Finally, it is hoped that this study will contribute to the reduction of existing barriers to the full exercise of the citizenship of people with disabilities.

As future research, it is suggested that ways be identified to make accessibility assessment and transparency even more feasible, with automated assessment methods such as the one shown here in order to conduct longitudinal research.

Bibliography

About HTTP Archive. (n.d.). Retrieved May 19, 2019, from https://httparchive.org/about

Baldo, F. S. (2019, May 20). Lista de sites da prefeituras Brasileiras. Contribute to franklinbaldo/sites_prefeituras development by creating an account on GitHub. Retrieved May 19, 2019, from https://github.com/franklinbaldo/sites_prefeituras (Original work published May 20, 2019)

Brazil. *Lei 10.098/2000.* , Pub. L. No. 10.098 (2000).

Brazil. *Decreto Legislativo 186/2008.* , (2008).

Brazil. *Lei nº 12.527 de 18 de novembro de 2011.* , (2011).

Brazil. *Lei Brasileira de Inclusão da Pessoa com Deficiência.* , Pub. L. No. 13.146 (2015).

Camp, R. C., & Camp Robert, C. (1989). *Benchmarking: the search for industry best practices that lead to superior performance.*

CGU. (2013). *Guia de implantação de Portal da Transparência.* Retrieved from https://www.cgu.gov.br/Publicacoes/transparencia-publica/brasil-transparente/arquivos/guia_portaltransparencia.pdf

Controladoria Geral da União. (2019). Escala Brasil Transparente. Retrieved March 6, 2019, from Controladoria-Geral da União website: http://www.cgu.gov.br/assuntos/transparencia-publica/escala-brasil-transparente-360/escala-brasil-transparente

Current Members - W3C. (n.d.). Retrieved April 6, 2019, from https://www.w3.org/Consortium/Member/List

Deque Labs. (2019). *axe-core* [JavaScript]. Retrieved from https://github.com/dequelabs/axe-core (Original work published 2015)

DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, *48*(2), 147–160. https://doi.org/10.2307/2095101

eMAG - Modelo de Acessibilidade em Governo Eletrônico. (n.d.). Retrieved April 6, 2019, from http://emag.governoeletronico.gov.br/#s1.3

Flores, D. M. (2012). *Um estudo histórico sobre as leis de acesso à informação no Brasil de 1991 até 2012.* Retrieved from https://lume.ufrgs.br/handle/10183/67158

Freudenberg, M. (2003). *Composite Indicators of Country Performance*.
    https://doi.org/10.1787/405566708255

Gerrish, E., & Spreen, T. L. (2017). Does Benchmarking Encourage Improvement or
    Convergence? Evaluating North Carolina's Fiscal Benchmarking Tool. *Journal of Public
    Administration Research and Theory*, *27*(4), 596–614.
    https://doi.org/10.1093/jopart/mux018

Giffinger, R., Haindlmaier, G., & Kramar, H. (2010). The role of rankings in growing city
    competition. *Urban Research & Practice*, *3*(3), 299–312.
    https://doi.org/10.1080/17535069.2010.524420

Google Developers. (n.d.). Auditar apps da Web com o Lighthouse. Retrieved April 8, 2019, from
    Tools for Web Developers website: https://developers.google.com/web/tools/lighthouse/

Google Developers. (n.d.). Lighthouse Scoring Guide. Retrieved April 8, 2019, from Tools for
    Web Developers website:
    https://developers.google.com/web/tools/lighthouse/v3/scoring?hl=pt-br

Heeks, R. (2008). Benchmarking e-Government: Improving the national and international
    measurement, evaluation and comparison of e-Government. In *Evaluating Information
    Systems: Public and Private Sector* (pp. 257–301).
    https://doi.org/10.1016/B978-0-7506-8587-0.50017-2

Henry, S. L., Abou-Zahra, S., & Brewer, J. (2014). The Role of Accessibility in a Universal Web.
    Proceedings of the 11th Web for All Conference, 17:1–17:4.
    https://doi.org/10.1145/2596695.2596719

Holzner, B. (2007). Transparency and Global Change. In G. Ritzer (Ed.), *The Blackwell
    Encyclopedia of Sociology* (p. wbeost049).
    https://doi.org/10.1002/9781405165518.wbeost049

HTTP Archive. (n.d.). Report: Accessibility. Retrieved May 19, 2019, from HTTP Archive
    website:
    https://httparchive.org/reports/accessibility?start=2016_02_15&end=2019_04_01&view
    =list

IBGE. (2015). Perfil dos Municípios Brasileiros. Retrieved May 21, 2019, from
    https://munic.ibge.gov.br/

KLEIN, C. R., & FREIRE, F. S. (2017). *Uma análise comparativa dos Indicadores de
    Transparência aplicados no Brasil*. Presented at the XVI CONGRESSO
    INTERNACIONAL DE CONTABILIDADE E AUDITORIA–2017, Aveiro, Portugal.
    Retrieved from https://www.occ.pt/dtrab/trabalhos/xviicica/finais_site/69.pdf

Kromidha, E. (2012). Strategic e-government development and the role of benchmarking.
    Government Information Quarterly, *29*(4), 573–581.
    https://doi.org/10.1016/j.giq.2012.04.006

McKinney, W. (2010). *Data Structures for Statistical Computing in Python*. 51–56. Retrieved from
    http://conference.scipy.org/proceedings/scipy2010/mckinney.html

McKinney, W., & Team, P. D. (2015). Pandas—powerful Python data analysis toolkit.
    Pandas—Powerful Python Data Analysis Toolkit, 1625.

Michener, G. (2011, July). Leis de Acesso à Informação: dilemas da implementação. Retrieved
    December 14, 2014, from Estudos em Liberdade de Informação website:
    http://artigo19.org/doc/Estudos%20em%20Liberdade%20de%20Informa%C3%A7%C3%
    A3o%201%20%28web%29.pdf

Michener, G., Contreras, E., Niskier, I., Michener, G., Contreras, E., & Niskier, I. (2018). From
    opacity to transparency? Evaluating access to information in Brazil five years later. *Revista
    de Administração Pública*, *52*(4), 610–629. https://doi.org/10.1590/0034-761220170289

Ministério do Planejamento. (n.d.). ASES - Avaliador e Simulador de Acessibilidade em Sítios.

Retrieved April 28, 2019, from http://asesweb.governoeletronico.gov.br/ases/

Ministério Público Federal. (2015). O Projeto. Retrieved October 26, 2018, from Ranking Nacional da Transparência website: http://combateacorrupcao.mpf.mp.br/home/ranking/o-projeto-new

Mitnick, B. M. (2015). Agency Theory. In *Wiley Encyclopedia of Management* (pp. 1–6). https://doi.org/10.1002/9781118785317.weom020097

Munda, G., & Nardo, M. (2003). *On the Methodological Foundations of Composite Indicators Used for Ranking Countries*. 19.

OECD, O. for E. C. and D. (2008). *Handbook on constructing composite indicators: methodology and user guide*. Retrieved from https://www.oecd.org/sdd/42495745.pdf

Perez, F., & Granger, B. E. (2007). IPython: A System for Interactive Scientific Computing. *Computing in Science Engineering*, *9*(3), 21–29. https://doi.org/10.1109/MCSE.2007.53

Sobre o Atlas. (n.d.). Retrieved May 21, 2019, from O Atlas | Atlas do Desenvolvimento Humano no Brasil website: http://www.atlasbrasil.org.br/2013/pt/o_atlas/o_atlas_/

Sobre o Avaliador. (n.d.). Retrieved March 6, 2019, from http://www.dasilva.org.br/institucional/24/sobre-o-avaliador

Stewart, D. R. "Chip." (2010). Let the Sunshine In, or Else: An Examination of the "Teeth" of State and Federal Open Meetings and Open Records Laws. *Communication Law and Policy*, *15*(3), 265–310. https://doi.org/10.1080/10811680.2010.489858

Stiglitz, J. (1999). *On Liberty, the Right to Know, and Public Discourse: The Role of Transparency in Public Life*. Retrieved from http://www.internationalbudget.org/wp-content/uploads/On-Liberty-the-Right-to-Know-and-Public-Discourse-The-Role-of-Transparency-in-Public-Life.pdf

Tim Berners-Lee. (2019). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=Tim_Berners-Lee&oldid=891676918

Transparency International. (2018). Research - CPI - Overview. Retrieved May 26, 2019, from https://www.transparency.org/research/cpi/overview

Tribunal de Contas do Estado do Paraná. (2019). ITP - Índice de Transparência da Administração Pública - Portal TCE-PR. Retrieved May 2, 2019, from https://www1.tce.pr.gov.br/conteudo/itp-indice-de-transparencia-da-administracao-publica-controle-social-controle-social/317844

United Nations. *Convention on the Rights of Persons with Disabilities*. , (2006).

Vidoli, F., & Fusco, E. (2018). *Compind: Composite indicators functions based on frontiers in R*. 23.

W3C Brasil. (2018). *Cartilha de acessibilidade na web [livro eletrônico] : fascículo III*. Retrieved from http://www.w3c.br/pub/Materiais/PublicacoesW3C/cartilha-w3cbr-acessibilidade-web-fasciculo-III.pdf

W3C Brasil. (n.d.). Cartilha de Acessibilidade na Web. Retrieved April 27, 2019, from http://www.w3c.br/Materiais/materiais/cartilha-w3cbr-acessibilidade-web-fasciculo-III.html

W3C Mission. (n.d.). Retrieved April 6, 2019, from https://www.w3.org/Consortium/mission#principles

W3C WAI. (n.d.). Evaluating Web Accessibility Overview. Retrieved April 27, 2019, from Web Accessibility Initiative (WAI) website: https://www.w3.org/WAI/test-evaluate/