Use and Production of FLOSS in Brazilian States: an Wider Survey

Flávio Gomes da Silva Lisboa
ETEC Bento Quirino
Campinas, Brazil
https://orcid.org/0000-0002-9396-7944

***Abstract*—This article presents a quantitative and qualitative exploratory research on the use and production of free/libre and open source software (FLOSS) by Brazilian states. Each one of the 26 states and the federal district was interrogated through access to information platforms and other specific eletronic information request forms between 2023 and 2024. This research fills a gap on the use of free software by Brazilian states. This research shows which are the most used software and software categories, the licenses that occur the most, the biggest FLOSS users among the states.**

***Keywords*—*Brazil; free software; public software; states;* survey.**

I. Introduction

Brazil has 26 states and 1 federal district. 22 states have their own information technology companies. 2 states (Maranhão and Rondônia) have a specific information technology department. Some companies develop software and others hire third parties to develop for their states. All of them provide or mediate infrastructure for the consumption of software as a service. All of them deal with information technology infrastructure that uses software.

At the beginning of the 21st century, some Brazilian states passed laws that gave preference to the use of free and open source software: Rio Grande do Sul, in 2002, Paraná in 2003 and Santa Catarina in 2004. These laws were passed during a period in which the federal government had a policy of promoting the use of free software. In previous editions of Latin.Science, we were able to have a broad view of the use of free software in federal institutions, but we do not yet have the same view for the Brazilian states.

A search carried out on the Brazilian Portal of Open Access Scientific Publications and Data (Oasisbr) in August 2024 for "use of free software" (in Portuguese) returned 38 documents published between 2004 and 2021. These articles, dissertations and theses address the use of free software in companies and even in schools, but do not address the use of free software broadly by state institutions, that is, by all their departments and autarchies.

In the same month, a search carried out on the Journals Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES in the Portuguese acronym) returned only one article for the expression “usage of free software” - an article about the federal government – and 28 documents for the expression “use of free software”. Only one of the documents addressed investment by a state government in the use of free software, and this use was limited to the field of education.

In order to contribute to a historical mapping of free software in Brazilian government institutions, and to know what is the legacy of state laws supporting free software, this article aims to answer the following questions:

- Do Brazilian state governments use free software?
- What free software do these governments use?
- Do any of these governments prefer to use free software?
- Have these governments produced any free software?

With the answers to these questions, this article aims to reduce a gap in knowledge about the use of free software in the state sphere of government in Brazil and thus contribute to future research, which can delve deeper into the specific use of the software that is discovered.

In the next sections we will explain the methodology for collecting data, present the results obtained, discuss the results and difficulties faced in the collection and analysis, present the conclusions and conclude with steps for future research.

II. Methodology

To answer the research questions, we used a legal instrument related to government transparency. The access to information law [1] determines that government agencies and entities must manage information transparently, providing broad access to it and its dissemination.

To comply with the law on access to information, governments can use several communication channels, as long as anyone can access at least one of them. We decided to use the states' digital information systems to make the information request because they create an auditable trail of the process, storing all communication between the requester and the state agency in question.

The questions were initially directed to the secretariat of the civil house, or the administration, depending on the state's organizational structure. So we can find out if the senior management was aware of which entity was responsible for information technology and whether the demand would be passed on to that entity. When this first instance didn’t provide information, we sent the questions to

the state information technology companies and to the information technology departments when there was one of them (the Federal District and the states of Mato Grosso do Sul and Roraima do not have state-owned information technology companies or information technology departments). We are talking about structures directly linked to the first echelon of the state government. Occasionally, the secretariats of these states may have information technology support teams, but they are operational and not strategic units.

The survey questions were reduced to three questions to be submitted and are as follows:

1. What are the free software used by the agencies of the State of [NAME] and what are they used for?
2. Does the State of [NAME] have a policy of buying proprietary software even if there is free software with the same functionality?
3. Has the State of [NAME] developed any free software through its agencies?

Requests for information were sent between June 1 and 12, 2023. The last response, from the state of Piauí, was received on October 26, 2023. It was necessary to open 4 complaints, appeal to a higher authority 4 times and make 20 new requests for information during this period.

According to Brazilian access to information law, states have twenty days to provide a response, with the possibility of an extension of thirty days. So, for example, if you need to make a new request, it may take two months to receive a definitive response.

Most states have their own information access system and there is a variety of user interfaces, although some states share the same format for generating reports with responses. Four states (Mato Grosso do Sul, Piauí, Roraima and Tocantins) use the federal government's information system, Fala.BR.

We took the opportunity to investigate whether information access systems used free software. Using Netcraft's Site Report, we discovered that 3 information access portals use ASP.NET, 4 use PHP, and 2 use Java on the server. The tool did not discover the server language of the remaining portals.

The responses were recorded in spreadsheets for accounting and analysis. We checked the licenses of the software provided to verify that it was truly free and we looked for the source code and license of the software that was supposedly produced by some states. Regarding the software acquisition process and the possible preference for free software, we grouped the responses into categories.

III. Results

A. *Free Software Usage*

In Table 1 we show the amount of free software used by each state that provided this information. It is important to clarify that the states that do not appear in the table may use free software, but we cannot confirm this due to the lack of data. The justifications for the lack of information on the use of free software are presented in Section IV of this article. 22 states mentioned at least one free software used. The 4 states that did not provide a list of free software used were: Amapá (AP), Ceará (CE), Mato Grosso (MT) and São Paulo (SP). For reasons of space, Table 1 uses the state codes, which are defined in the ISO 3166-2:BR [2].

TABLE 1
FREE SOFTWARE USAGE INFORMED BY STATE

State	Quantity	GDP 1 mi R$ (2021)
AC	12	21,374
AL	89	76,266
AM	2	131,531
BA	1	352,618
DF	8	286,944
ES	2	186,337
GO	23	269,628
MA	15	124,981
MG	1	857,593
MS	42	142,204
PA	18	262,905
PB	9	77,470
PE	7	220,814
PR	6	549,973
RJ	4	949,301
RN	3	80,181
RO	21	58,170
RR	12	18,203
RS	7	581,284
SC	30	428,571
SE	5	51,861
TO	2	51,781

From Table 1 we can see that the three largest users of free software are the states of Alagoas (AL) with 89, Mato Grosso do Sul (MS) with 42 and Santa Catarina (SC) with 30.

We added a column to Table 1 with the gross domestic product (GDP) of each state, in millions of reais (R$) [3], to make a comparison between the wealth produced by the state and the use of free software. The motivation for this comparison is the discourse of several political actors in favor of the use of free software to supposedly save public money by not having to pay for software licenses [4]. If saving on licenses is a factor with great weight in the choice of software, we can assume that states with fewer financial resources would be more likely to adopt free software than those with more resources. However, as we can see from the

table, there is no linear relationship between the wealth of the state and the amount of free software used.

The state that uses the most free software, based on the data collected, is Alagoas (AL). This state ranks twentieth in Brazil's GDP ranking. The poorest state in the Brazilian federation, however, is Roraima (RR). The states that use the least free software, Bahia (BA), Minas Gerais (MG), with only one software each, occupy, respectively, the seventh, and third positions in the GDP ranking. The richest state in the table is Rio de Janeiro, which occupies the second position in the GDP ranking. Rio de Janeiro, however, has more software than states with lower GDPs, such as Amazonas, Espírito Santo and Tocantins, for example.

TABLE 2
MOST USED FREE SOFTWARE

Software	User states
PostgreSQL	9
LibreOffice	8
Nginx	8
Linux (several distributions)	8
Apache HTTPD	7
MySQL	6
Grafana	5
Kubernetes	5
PHP	5
Python	5
Zabbix	5
Zimbra	5
Docker	4
Elasticsearch	4
Gitlab	4
Java	4
Laravel	4
Moodle	4
Nextcloud	4
SEI	4
SonarQube	4
Wordpress	4
Ansible	3
CentOS	3
Git	3
MariaDB	3
MinIO	3
MongoDB	3
OCS Inventory	3
Tomcat	3
Ubuntu	3

We identified 178 software programs used by Brazilian states. It is important to clarify that we collect the number of software products and not the number of installed instances. Table 2 shows the software most used by Brazilian states, with at least three user states. The most widely used software is PostgreSQL, used by Alagoas (AL), Maranhão (MA), Mato Grosso do Sul (MS), Pará (PA), Paraíba (PB), Pernambuco (PE), Paraná (PR), Santa Catarina (SC) and Sergipe (SE).

The following software is used by only two states each:

- Bind / Named (AL and DF);
- Bootstrap (AL and MA);
- Drupal (PE and PR);
- FreeBSD (AC and AL);
- GLPI (AL and ES);
- Heimdall (MS and RO);
- JBoss (MS and PA);
- Kafka (MS and RO);
- Kong (MS and RO);
- Matomo (MS and RO);
- Memcached (AL and GO);
- OpenLDAP (AC and AL);
- OpenStreetMaps (AL and PR);
- OwnCloud (AC and AL);
- pfSense (AL and RR);
- pgAdmin (PA and SC);
- Prometheus (AL and MS);
- RabbitMQ (MS and RO);
- React Native (AL and MA);
- Redis (GO and MS);
- SOLR (AL and SC);
- Visual Studio Code (MS and SC);
- Vue.JS (PR and SC).

Eight states reported using Linux, but did not identify the distribution. We grouped these unidentified distributions into the category “Linux (several distributions)”. Some distributions were identified, such as CentOS (used by the Federal District (DF), Maranhão (MA) and Mato Grosso do Sul (MS)), Debian (used by Maranhão) and Ubuntu (used by Alagoas (AL), Maranhão e Santa Catarina).

We see that there are two relational database management systems among the most used software: PostgreSQL and MySQL. MySQL is used by the states of

Alagoas, Maranhão, Mato Grosso do Sul, Rio Grande do Sul, Santa Catarina and Sergipe.

We can also see three programming languages used: Java, PHP and Python. Java is used by Alagoas, Pará, Paraíba, Paraná and Santa Catarina. PHP is used by Acre, Alagoas, Pará and Rio Grande do Sul. Python is used by Alagoas, Pará, Paraíba, Rio Grande do Sul and Santa Catarina.

Licensing is a fundamental aspect of free software, as defined by the Free Software Foundation. It is not enough for the code to be open source; a license is required to ensure that the software can be freely used, studied, modified and redistributed. The software identified in this research has several licenses and, sometimes, a software has more than one license. In Table 3, we list the licenses that occur most frequently in the software we identified.

TABLE 3
MOST FREQUENT LICENSES

License	Occurrences
Apache License 2.0	31
GPL	15
GPL 2.0	26
MIT License	34

We identified 34 different licenses. In this identification, we distinguish different versions of the same license. Thus, GPL, GPL 2.0 and GPL 3.0 are counted as distinct licenses.

B. Free Software Production

The Acre (AC) government responded that it developed its platforms using open source tools (a necessary condition for software to be free). The state cited three portals as examples, but the source code of these portals is not freely available. The Acre government itself clarifies that these portals "are shared only with the public sector free of charge and collaboratively, through technical cooperation agreements between the entities". Thus, although they are produced with free software, they are not free software.

The government of Alagoas (AL), which, according to the data obtained, is the largest user of free software in the Brazilian federation, reported that "software developed using Open Source technology is for the exclusive use of the State Government". In other words, the government of Alagoas uses free software, but does not produce free software.

The states of Amazonas (AM), Espírito Santo (ES), Mato Grosso do Sul (MS), Mato Grosso (MT), Paraná (PR), Rio de Janeiro (RJ), Roraima (RR), Rio Grande do Sul (RS), Santa Catarina (SC), Sergipe (SE), São Paulo (SP), Tocantins (TO) and the Federal District (DF) reported that it does not develop free software.

The government of Amapá (AP) responded that "almost all of PRODAP's [the state-owned information technology company] production is done with free software [...]. Currently, the source code of the developed systems is not available" (our translation). In other words, Amapá uses free software, but does not produce free software.

The states of Bahia (BA), Ceará (CE) and Goiás (GO) responded that it does not have information about the production of free software, that is, they does not know whether they produced it or not.

The information technology department of the Maranhão (MA) government responded that all applications developed by it are made with open source tools and that they are open source. It added that these applications "are subject to the transfer of source code, for use or improvements thereof" (our translation). This last statement, together with the lack of a source code repository for these systems, leads us to the conclusion that Maranhão has not produced any free software, because without open source code, there is no free software.

The state of Minas Gerais (MG) provided two responses, through different agencies. The planning department stated that it has no control over the development of free software, while the state-owned information technology company stated categorically that it does not develop free software.

The state of Pará (PA) had not responded by Latin.Science's original submission deadline, but that state's data processing company (PRODEPA) sent a response shortly before the extended deadline.

The states of Piauí (PI) and Rio Grande do Norte (RN) did not respond to this question.

The state of Paraíba (PB) provided the address of a source code repository: https://github.com/codata-gedes. During the data collection period, we found that there were 10 projects in this account. 8 projects were forks of other free software projects, apparently customizations of demands that were not met by the communities maintaining the projects. 2 projects were exclusive creations of Codata, the information technology company of the state of Paraíba, but only one of them, the vue3-axios-plugin, had a free license (MIT). Thus, the state of Paraíba produced free software.

The information technology department of the state of Rondônia stated that it does not develop free software, but added that it did not have the information from other agencies.

The government of Sergipe stated that it created software that could be shared with other public entities, as other states reported, but unlike these, it recognized that this software was proprietary and not free.

We can group the responses about free software production by Brazilian states into 4 categories. Table 4 shows the occurrences of each response category. Note that the sum of occurrences (25) is less than the number of federative entities. This is because some states did not respond to the question. The sum would be lower if Minas Gerais had not given two different answers.

It is important to note that several responses about the production of free software reveal a lack of understanding of the concept, as software built using free software, but which does not have open source and a free license, is mistakenly considered to be free software.

TABLE 4
FREE SOFTWARE PRODUCTION BY BRAZILIAN STATES

Response	Occurrences
Claims to have created free software and really did it	1
Claims to have created free software, but didn't	1
Claims to develop with free software, but does not created free software	4
Claims not to have create	15
Don't know if it was created	5

Thus, we can state, based on the data collected and the source code and license verification, that only one Brazilian state produced free software. However, in the discussion, we will comment that there is data that contradicts the claim of one of the states in this regard.

C. *Free software acquisition policies*

From responses from the states, we identified five categories of acquisition policies for software, which includes the adoption of free software:

1. **Meeting requirements**: Most states responded that the choice of software is made based on requirements, which may involve issues beyond technical characteristics;
2. **Free software as first option**: Amazonas (AM), Rondônia (RO) and Santa Catarina (SC) responded that they prefer free software when they have to purchasing software;
3. **Technical support**: Four states, Espírito Santo (ES), Goiás (GO), Pará (PA) and Roraima (RR) responded that warranty, support and upgrades are the fundamental criteria for adopting software;
4. **Legislation:** the state of Paraíba declared that following regulations and jurisprudence is above licensing and checking characteristics;
5. **To be a Microsoft product**: Maranhão (MA) declared that there is preference for software from the Microsoft platform.

We realized that the issue of deciding whether to use free software or not was poorly understood by all states. The question was whether, given two software programs with the same characteristics, including available technical support, one being free and the other not, which would be adopted? The only acceptable difference would be the license, since proprietary software would not have a free license and would possibly charge for the license. But the answers served to discover how states generally guide themselves to adopt software.

IV. DISCUSSION

After presenting the results, we will discuss some discoveries made throughout the research and clarify some questions regarding the data obtained and the collection process.

The government of Alagoas sent a file with a list of free software and a description of the service provided by each software. Some states only sent the names of the software.

The government of Bahia reported two software programs, but only one of them is free, SEI. SEI is the acronym in Portuguese for Electronic Information System. This software is published on the Brazilian Public Software Portal. “Brazilian Public Software is a specific type of free software that meets the needs of modernizing the public administration of any of the Powers of the Union, the States, the Federal District and the Municipalities and is shared free of charge on the Brazilian Public Software Portal” (our translation) [5]. Three other states reported using SEI: Maranhão, Pernambuco and Rio de Janeiro. SEI is used as part of some information access systems.

The state of Amapá justified the lack of a list of free software used by stating that “PRODAP (state information technology company) does not have an inventory of software from government structure bodies”.

The state of Ceará justified the lack of a list of free software used by stating that “there is no centralized database with such information” (our translation). Regarding the software acquisition policy, the government of Ceará reported that there was a decree issued in 2008 [6] that established the preferential use of free software, but it was revoked in 2021.

The state of Espírito Santo reported only two software applications as examples, GPI and LibreOffice. We found that GPI (Graphical Programming Interface) is a development environment for scientific algorithms and the state reported that it used the software for attendance control. We then realized that there was a spelling error and the correct software was GLPI (*Gestionnaire Libre de Parc Informatique*, what means Free IT Park Manager). The government of Espírito Santo justifies the authorization of a complete list affirming that “considering the discretion and independence of the administration of each party we do not inventory our software in a centralized way to list all of our software” (our translation).

The government of Mato Grosso delegated the response to its state-owned information technology company, which reported the following: “We have no administration or control over the software used by the agencies of the State of Mato Grosso. MTI uses free software in the administrative

and technical areas. This is a very broad response, since there are hundreds of free software programs used in a wide variety of tasks" (our translation). Thus, the state of Mato Grosso reported that it uses free software, but did not list which ones.

The state of Minas Gerais did not report any of the free software used, justifying that "details of these open source systems cannot be disclosed, as they are internal, restricted, strategic and confidential information" (our translation). However, the government of Minas Gerais reported that it uses distributions of the Linux operating system and some free software from the following categories:

- Collaboration platform like email, writing software and delivery;
- Web conference platform;
- Platform for managing software development and collaborative environment projects;
- Solution to correlating events.

The final response from the Minas Gerais government was given by PRODEMGE (the state-owned information technology company). When searching for the keyword "free software" on the PRODEMGE website, we found an issue of a magazine published by the company (FONTE magazine) dedicated to free software [7]. The issue is from 2005, so from it we know that the company used free software that year and we know what some of them were.

FONTE magazine reports that, in 2005, all network servers and several workstations of the Minas Gerais Military Police used Alferes Linux, a distribution based on Kurumin. The same magazine reports that 90% of the servers at the Minas Gerais Department of Education used Linux. We therefore know that the state of Minas Gerais has been using Linux since at least 2005. The information about the operating system was the only one provided by the government of Minas Gerais, but not even the distribution was reported. Thus, in Table 1, we counted the use of only one free software for Minas Gerais, identified as "Linux - various distributions". Even though the magazine lists the Alferes distribution, we cannot assume that the government still uses it because it did not confirm this information.

When we requested information from the Pará government, the first response was an instruction to call a telephone number. We filed an appeal and had to complain because the appeal was not answered. When the response to the appeal came, it was as follows: "We will forward the request for information to the responsible department" (our translation). And there was no further response. We requested the information directly from the state information technology company, but it had not responded by the time this article was submitted for the first time. Two days before the extended deadline, the state information technology company (Prodepa) sent the response, finally. In addition, the third article of this regulation states that the objective of Prodepa includes "the encouragement and development of solutions based on free software" (our translation) [8].

The information technology company from the state of Paraná (Celepar) responded as follows: "Celepar does not develop free software, it only uses and participates in communities whenever appropriate" (our translation). However, according to Alberto Jorge Silva de Lima's thesis [9], Celepar created the free software Expresso, as a fork of eGroupWare, but soon turned it into an independent product. While the state of Paraná denied the creation of Expresso, the government of Pernambuco stated that it uses Expresso, which is groupware.

The state of Rio Grande do Sul declared Google Chrome as free software, but that software does not have a free license.

The information technology company of Santa Catarina (CIASC) reported SoapUI, Sublime Text and Talend as free software, but these software does not have available source code or a free license.

The state-owned information technology company of the state of São Paulo refused to disclose the names of the free software used, claiming that this could "harm or pose a risk to scientific or technological research and development projects, as well as to systems, assets, facilities or areas of national strategic interest" (our translation).

V. Conclusion

This research showed that the vast majority of Brazilian states and the Federal District (DF) use free software, among more than a hundred products.

We discovered that PostgreSQL, LibreOffice and Nginx and are the software used by the largest number of states and that software with an MIT license is the most used in the states, followed by software with an Apache license.

We discovered that the state of Paraíba (PB) was the only one that declared having produced free software and that it actually did.

We showed an inconsistency in the response of the state of Paraná (PR), which stated that it had not produced free software, in contradiction with the results obtained by a doctoral research.

We discovered that the question of choosing free software when there is proprietary software with the same characteristics was not clear to those responsible for the responses provided. Regarding this question, we ended up discovering that the states differ in relation to the premises for adopting a software.

In general, Brazilian states are characterized as users of free software, with little evidence of contributions to open source projects. It is a consumer relationship that seems to be based solely on the free license.

Something that caught our attention was the contradiction between the states of Minas Gerais (MG) and São Paulo

(SP), which claimed they could not say the name of the free software they used for security reasons, but freely disclose the name of proprietary software in their bidding notices.

The claims of vulnerability by the mere mention of names suggests that free software is viewed by these states as fragile software in terms of security.

It is important to note that this research was conducted in a variety of complex structures of public administration and management of information technology resources. Each Brazilian state, according to its constitution and laws, can create its own organization for the creation, development and use of information technology. Thus, we realized that it was easier to obtain information from some states than others, and sometimes with a greater or lesser level of detail.

VI. Next Steps

Based on the results of this research, it is possible to begin an investigation into the applications of the software found in each of the states, identifying the departments that use them. We know which software is used, but not the specific areas (health, education, public safety, etc.).

It is also possible to consider a survey that compares how each state uses the same software in order to discover whether one can contribute to improvements in the work process of the other.

Regarding software acquisition policies, considering cases such as Maranhão, it would be relevant to carry out a study on how agreements between government and software companies like Microsoft may impact software acquisition or the free software policies.

Another relevant study would be the comparison between the different state information technology structures, as well as the relationship between legislation on free software (when existing) and software acquisition policies.

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