Relationship between E-Government Development and State Capacity in Brazilian Municipalities: A Cluster and Correspondence Analysis

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ABSTRACT

This paper seeks to understand the relationship between state capacity and ICT usage dimensions. Local governments are responsible for delivering services and are highly impacted by their social, economic, and regional characteristics. For the quality and quantity of their services, governments need to have state capacity, that is, the ability to plan, execute, and evaluate their policies. In the same way, governments need to be able to use information and communications technology (ICT) to aid and improve their results. Based on statistical, cluster, and correspondence analysis methods of secondary data, our results show that most local governments have state capacity and ICT usage but lack sophistication. At the same time, a small group performs worse on both dimensions. The correspondence analysis evidences a strong correlation between state capacity and e-gov development at the local level. The results show that municipalities with greater technical-administrative and political-relational capacity are more advanced in e-gov.

CCS CONCEPTS

• **Applied computing**; • **Computing in other domains**; • **Computing in government**; • **E-government**;

KEYWORDS

E-Government, State Capacity, Local Government

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1 INTRODUCTION

This study investigates the relationship between e-gov implementation and state capacity. State capacity is the capacity to effectively formulate and implement public policies, physical infrastructure, technology, and financial resources [3]. Governments have increased the use of information and communications technology (ICT) over the years, resulting in discussions of electronic government (e-gov) [40]. E-gov aims to improve the supply and quality of public services, promoting efficiency and transparency, facilitating management of the environment as well as urban planning, and creating modern services that assist public demands.

E-Gov and state capacity are deeply affected by the local government context. Regional, environmental, educational, and financial dimensions are a few that limit how governments deal with their challenges. In Brazil, since 2006, there has been an effort by organizations such as the Comitê Gestor da Internet (Internet Steering Committee) to map e-gov initiatives, helping researchers to understand how digitalization processes and e-gov initiatives occur in municipalities [7]. Since then, studies have shown an increase, year after year, in governmental use of the Internet and digital services provision [41]. However, the regional location and size of the municipalities are factors that impact the delivery of services and infrastructure, leading to different characteristics and uses of ICT. Local governments in the South and Southeast regions tend to have better transparency, social participation, and digital inclusion. In contrast, those in the North and Northeast regions suffer the most from the lack of infrastructure and financial resources [22, 30, 36]. However, few studies have concentrated on understanding the relationship between e-gov development and state capacities.

Brazil is a federative country divided into three levels: federal government, state government, and municipal government. Municipalities constitute the governmental level closest to citizens and are responsible for education, health, urban planning, and social security. Since 1988's Constitution, the law has obliged them to offer more services such as education up to the middle school level and primary health care services [15]. Brazilian local governments heavily suffer from budgetary deficits. Such services do not have enough funding even with the local taxes and the financial resources they receive through federal and state transferences [4]. Most municipalities face barriers to using adequate planning instruments, training and retaining human resources, and executing participatory arenas [2, 11, 27].

Digital transformation has multiple benefits to local governments, aiding the execution of public policies and bureaucratic processes and offering new services through digital instruments [12, 24]. The presence of technological resources can be related to existing administrative capacity [32]. Hence, the present study tries to answer if local governments with solid state capacity also have good e-gov policies and governments with weak state capacity have ineffective e-gov policies. The study is based on data from the Pesquisa de Informações Básicas dos Municípios – 2019 (Municipalities Basic Information Research/Munic – 2019) produced by the Brazilian Institute of Geography and Statistics (IBGE). Additionally, municipal financial data were gathered at Siconfi (Brazilian Public Sector of Accounting Information System). The results contribute to discussions on how state capacity articulates with other sectors of public policy and e-gov policies [6, 15, 32]. The paper is divided into six parts: introduction, literature review, methodology, results, discussion, and conclusion.

2 STATE CAPACITY AND E-GOV DEFINITION

State capacity is the ability of governments to design, implement, and evaluate public policies [39]. The concept of state capacity was developed in the 1980s to understand why developing countries could not efficiently use international resources to implement policies and programs [25]. These studies did not obtain the expected results, leading to discussions pointing out that the parameters chosen to evaluate those countries were based on developed countries' standards. Since then, researchers have tried to model state capacity frameworks that translate their countries' reality and move from an economics-centered analysis toward a more multidimensional approach [5, 6].

The divergence in literature focuses on defining measurable indicators of state capacity. Some authors describe state capacity as a government's capacity to implement its policies in objective, regulatory, administrative, technical, and extractive dimensions [3, 13]. Others criticize the concept, questioning whether using state capacity to analyze governmental and policy performance is proper [38]. What can be apprehended from this discussion is that a state's operation is more complex than it seems. With the increase in governmental responsibilities, the number of stakeholders, forms of participation, technologies, and mechanisms make it more challenging to define the key components of state capacities.

Researchers divide state capacity into two dimensions: technical-administrative capacity, which represents human resources, adequate technological and financial resources availability, actions of implementation and evaluation, and tools of cooperation [28, 33]; and political-relational capacity, which encompasses interaction mechanisms between Executive and other actors and stakeholders, channels for participation in decision-making processes, and accountability systems [29, 33]. Gomide, Pereira, and Machado [8] were chosen as the framework for this paper because they articulate both dimensions: technical-administrative capacity and political-relational capacity. This theoretical framework allows us to understand government as an institution permeated by multiple actors and stakeholders who can implement and evaluate public policies through social participation, inter- and extra-organizational cooperation, and legislative and civil society mechanisms. This choice offers theoretical and analytical lenses that allow researchers to chart the local governments' main state capacity elements and measure their role in public policy results [6]. Brazilian literature on state capacity mainly focuses on federal-level policies; currently, some efforts have been made to analyze local levels [34]. To understand more about how local governments operate, researchers have tried to correlate technical-administrative and political-relational capacity with educational policy performance, urban participative processes, technological innovation, and human development and their respective observable indicators [1, 6, 15, 34].

The use of ICT by local governments is part of state capacity discussions on recognizing its transversal role in governmental activities and improving public policy efficiency, efficacy, and effectiveness [32]. There is evidence of the benefits of ICT use by the public sector, where technical-administrative capacity is related to the availability of technological resources in governmental institutions. The digitization of a state occurs by transforming the delivery of services and the channels through which institutional processes happen inside the government. This continuous process is an improvement of ICT use, aiming to enhance the public administration's internal organization and satisfy citizens' needs and expectations [5, 10]. This fast process affects governments, companies, organizations, and society, bringing cultural and behavioral changes in social, political, and economic practices with ICT as a starting point [24].

In recent years, studies of e-gov have put the use of ICT in the spotlight, given the acceleration of digital transformation [17, 26]. ICT can be broadly used to improve the supply and quality of public services, promote governmental efficiency, and increase transparency [15]. From the local government perspective, e-gov primarily aims to solve a population's daily demands by delivering services [13]. The literature emphasizes that, given the lack of needed infrastructure, municipalities' use of ICT leads to the suboptimal use of technologies, resulting in negative impacts on the implementation of e-gov [30].

E-gov is defined by services delivered and applications through the Internet and digital platforms [37]. ICT-provisioned services try to improve and increase the public value generated by services offered to citizens and strengthen government–citizen and government–stakeholder relationships. Simultaneously, ICT use modernizes and innovates the public sector by reinforcing public services' management, production, and provision [21]. To sustain governmental digital transformation policies, they must attract qualified human resources, execute organizational reforms and planning, and change their organizational culture to face new policies and tools [21]. Digitization processes and the improvement of state capacity walk alongside each other. ICT usage allows governments to improve their management, services, and product delivery. For its implementation, however, governments need adequate state capacity, such as human resources capable of using it. The success of digital transformation projects needs support from the managers, rulers, leaders, and stakeholders involved in decision-making processes [9, 23].

Local governments' conditions for state capacity and ICT use are enhanced in combination. For their development, governments need adequate and available financial resources, infrastructure for service provision and administrative processes, qualified human resources

for implementing and developing policies, and the presence of leadership to push the agenda of digital transformation and public management modernization. In this article, we seek to understand the relationship between local governments and state capacity and the development of e-gov.

3 METHODOLOGY

A quantitative approach was used to identify the relationship between ICT usage and state capacity in Brazilian municipalities through descriptive data analysis, clustering, and correspondence analysis algorithms. For treatment, organization, and to describe data, the language "R" was used. Afterwards, clustering algorithms were used to identify patterns between municipalities in each database to create two cluster groups: for ICT usage and for state capacity. The cluster technique aims to group observations based on their defined characteristics, given their similarities and differences [20]. The results of this technique are groups that are internally homogeneous and externally heterogeneous [18]. The municipalities were grouped in each cluster where their ICT usage and state capacity profile was similar, while other municipalities were grouped in other profiles for each dataset. After the identification and cluster analysis, the results were applied to the correspondence analysis algorithm (CA) to verify the relationship between ICT usage and state capacity. CA aims to establish a statistical relationship between categorical variables (in this case, the clusters) and create a perceptual map output [18]. Cluster analysis results in a qualitative variable that fits the input needs of CA. For this research objective, correspondence analysis determines how the ICT usage and state capacity cluster association occurs and helps to understand the direction of this relation [35].

The ICT usage profile is based on the results of Figueiredo e Przeybilovicz (2022) and the framework and procedures adopted and applied in other studies that investigated the profile of Brazilian municipalities regarding their ICT use [30–32, 36]. These dimensions analyzed were the following: 1) Prefecture connection infrastructure maps the governmental connection infrastructure and its ICT resources for the connection. 2) E-services and communication with citizens observe the range of public services provided and the means of communication available to the public to consume those services. 3) Digital inclusion comprehends the governmental effort toward allowing citizens to access the Internet and communication devices (such as a computer) and to be able to use these resources. 4) E-transparency tracks how the government makes data and information available and answers to the Information Access Law [30, 31].

Coelho et al.'s [6] state capacity approach based on Gomide et al. [8] was adopted. In this framework, state capacity has two main dimensions: technical-administrative capacity and political-relational capacity. Technical-administrative capacity was divided into four lesser dimensions, the first of which is human resources, which has five variables: total direct administration public servants for 10,000 inhabitants, percentage of statutory servants out of total servants, percentage of servants with middle school education, percentage of servants with high school education, and percentage of servants with higher education. The human resources dimension measures the availability and quality of human resources. With the chosen variables, we can measure the amount of human resources available to work in cities, the percentage of which is statutory, where they were admitted through public examinations and are a proxy to bureaucratic professionals in governments. In contrast, the level of education in each category shows how well-educated the public servants are [1, 2, 6, 15, 16].

Financial resources are concerned with total taxes enforced, IPTU enforced (Urban Property Tax), receipt per citizen, and financial dependence. Financial resources measure how prefectures deal with their budgetary low elasticity, capacity to tax-collect resources, and dependence on financial transferences from the federal government [4, 6, 15, 16]. The planning and management tool includes the number of municipal plans, the existence of a computerized real state registry, an updated generic valuation map for the previous 10 years, the existence of ISSQN (registry of municipal service taxpayers), and the existence of a master plan (a document that dictates the usage of soil and construction within a city). This dimension measures how well-established the mechanisms are that every prefecture can have to improve its management and planning. The municipal plan dictates how resources will be spent in each public sector. The master plan shows if cities have urban planning. Registries demonstrate if a city has updated resource control [6, 15, 16, 27]. The technical-administrative capacity dimension concerns management structures, measured by a prefecture's number of secretaries. This variable maps the range of specialized structures that a local government has [6].

Political-relational capacity is divided into three lesser dimensions, the first of which is interfederative arrangements, which measures how many public partnerships with other federative units (federal, state, and municipal governments) it has and with which federative unit they have partnerships [6, 14, 16]. Institutional participation channels measure the number of public councils that a prefecture has. This dimension maps the number of spaces for civil society participation [6, 11]. Internal and external control mechanisms are the last lesser dimension and are divided into three variables, namely the existence of internal control, whether it is exclusive or direct under the Executive office or is subordinated to another unit, and the existence of the transparency council (which verifies the existence of accountability and social participation and the level of autonomy of internal control) [6, 11]. For control variables, gross domestic product, Human Development Index, and total population were used [6, 15, 16, 34].

The primary data were extracted from Munic by IBGE. Munic is research that has been conducted since 1999 with all Brazilian municipalities, with 2022 being the latest edition. 2019 and 2018 were used, consisting of all 5,570 municipalities, and the variables described above were chosen (Tables 1 and 2) for the creation of the datasets for ICT usage and state capacity. Accounting and financial data were extracted from Siconfi API, which is the National Treasury system that holds all financial data from Brazilian municipalities. Also used were gross domestic product from IBGE and the Municipal Human Development Index (M-HDI) from Human Development Atlas in Brazil from 2010.

After the exploratory data analysis of the data sources, 774 municipalities without information on the analyzed variables were excluded. The ICT usage variables were standardized as "1" for event and "0" for no event. For the ICT usage database, the final

Table 1: Dimensions, Variables, and Descriptive Summary of Information and Communications Technology (ICT)

Dimensions	Variables	Mean	Std. Dev.
Prefecture connection infrastructure	Possess working computer	1.44	0.58
	Possess intranet	0.44	0.50
	Online website	0.98	0.15
E-services and communication with citizens	Distance services through the available Internet	0.89	0.31
	Informative service	0.87	0.34
	Access to documents	0.68	0.47
	General information on public tenders	0.89	0.31
	Ombudsman and citizen services	0.74	0.44
	Process consultation and protocol follow-up	0.37	0.48
	Previous consultation	0.17	0.38
	Official journal, municipal legislation, and public finances	0.78	0.41
	Public recruitment process	0.79	0.41
	Online school enrollment in the public education system	0.04	0.19
	Issuance of a negative certificate of debt	0.36	0.48
	Booking appointment in the public health system	0.03	0.18
	Development of digital inclusion program/action	0.55	0.50
Digital inclusion	Public access availability	0.33	0.47
	Bridge between partners	0.05	0.21
	Computer installation in the public education system	0.44	0.50
	Wi-Fi connection availability	0.41	0.49
	Municipal public information legislation in accordance with the Information Access Law	0.45	0.50
E-transparency	Means to request access to public information through the Internet	0.86	0.34
	Information access requests answered in 2018	0.46	0.50
	Real-time information available	0.74	0.44
	Competency record	0.53	0.50
	Organizational e-structure	0.75	0.43
	Unit address and phone number	0.87	0.34
	Public service schedule	0.79	0.41
	Transference register	0.67	0.47
	Public expenditure data published	0.98	0.14
	Programs monitoring general data	0.88	0.32
	Public biddings processes information	0.48	0.50
	Frequently answered questions	0.35	0.48
	Data published in open format	0.42	0.49
	Data are updated	0.75	0.43

sample consists of 5,568 municipalities and 37 variables, while for state capacity, 4,797 municipalities used 26 variables.

The dendrogram method was used for both clustering methods to select the number of clusters. It was decided that four to six clusters would be analyzed; ultimately, four clusters were chosen for each dataset. For ICT usage, the Gower method with Ward distance was used for its best results with binary variables [19, 20]. The k-means method with Canberra distance was used for its best results with multivariate variables for state capacity. Regarding the results and analysis of both clusters, the CA algorithm was applied in order to verify the relationship between ICT usage and state capacity. A non-parametric chi-squared test ($chi^2 = 258.81$) was performed to validate the CA results, showing a statistical association between the variables [18].

4 RESULTS

The analysis resulted in four clusters of municipalities' ICT usage characteristics. Cluster 1 (Lagged) represents the lowest response to digital inclusion and the average response to the other dimensions. Cluster 2 (Advanced) includes municipalities with the best performance in all dimensions. Cluster 3 (Average) has average responses to connection infrastructure and e-services and low responses to digital inclusion and e-transparency. Cluster 4 (Behind) includes municipalities with the worst average response to all dimensions [36].

Table 2: Dimensions, Variables, and Descriptive Summary of State Capacity

Dimensions	Variables	Mean	Std. Dev.
Human resources	Public servants by 10,000 inhabitants	512.65	226.87
	Percentage of statutory public servants	0.61	0.23
	Percentage of public servants with middle school education	0.19	0.10
	Percentage of public servants with high school education	0.40	0.11
	Percentage of public servants with higher education	0.29	0.11
Financial resources	Total tributes enforced	2.47	1.24
	Receipt per citizen	$4,300.34	$2,228.34
	Financial dependence	0.39	0.18
	IPTU enforcement	0.95	0.23
Management tools	Total number of municipal plans	4.00	0.49
	Existence of computerized real state registry	0.80	0.40
	Updated generic valuation map for the previous 10 years	0.47	0.50
	Existence of ISSQN (registry of municipal service taxpayers)	0.97	0.16
	Existence of a Master plan	0.52	0.50
Management structures	Total number of secretaries	2.60	1.19
Interfederative arrangements	Public partnership dimensions	1.80	2.57
	Intramunicipal partnership	0.68	0.47
	State partnership	0.08	0.28
	Federal partnership	0.01	0.08
Institutional participation channels	Total number of public councils	8.73	1.98
Internal and external control mechanisms	Existence of internal control institution	0.94	0.23
	Internal control institution is autonomous	0.77	0.42
	Existence of transparency council	0.01	0.10
Control variables	Gross domestic product per capita	$24,320.87	$24,907.20
	Municipal Human Development Index	0.66	0.08
	Total population	39,351.24	237,421.45

Table 3: ICT Cluster Result Analysis

Clusters	Prefecture Connection Infrastructure	E-Services and Communication with Citizens	Digital Inclusion	E-Transparency
1 – Lagged	0.8	0.59	0.06	0.7
2 – Advanced	0.84	0.65	0.52	0.75
3 – Average	0.8	0.59	0.29	0.53
4 – Behind	0.69	0.25	0.19	0.43

Cluster 1 (Lagged) has good averages regarding infrastructure, e-services, and e-transparency compared to the other clusters and almost zero value regarding digital inclusion. Medium-sized and small municipalities form this cluster, with populational settlements predominantly in the Northeast, South, and North regions. It has an average population of 19,997 inhabitants, with $1,470 in receipts per capita, $4,536 in GDP per capita, and an M-HDI of 0.659.

Cluster 2 (Advanced) performs best in all dimensions and variables, comprising 40% of the sample (2,257 municipalities). It has an average population of 61,087 inhabitants due to the presence of cities like São Paulo, Rio de Janeiro, and Brasília, with $1,323 in receipts per capita, $5,490 in GDP per capita, and an M-HDI of 0.679. Given its size, this cluster has a significant presence in all regions.

Table 4: State Capacity Cluster Result Analysis

Dimensions	Variables	A-Lagged	B-Average	C-Advanced	D-Behind
Human resources	Public servants by 10,000 inhabitants	559.21	493.88	456.86	590.70
	Percentage of statutory public servants	64%	57%	62%	56%
	Percentage of public servants with middle school education	21%	19%	19%	18%
	Percentage of public servants with high school education	41%	41%	39%	43%
	Percentage of public servants with higher education	28%	31%	30%	28%
Financial resources	Total tributes enforced	2.43	2.40	2.77	1.66
	Receipt per citizen	$4,531.41	$4,086.01	$4,411.50	$3,495.28
	Financial dependence	0.42	0.38	0.35	0.49
	IPTU enforcement	0.96	0.99	1.00	0.61
Management tools	Total number of municipal plans	3.93	4.03	4.05	3.95
	Existence of a computerized real state registry	0.75	0.98	0.96	0.04
	Updated generic valuation map for the previous 10 years	0.46	0.51	0.53	0.25
	Existence of ISSQN (registry of municipal service taxpayers)	0.97	0.99	0.99	0.86
	Existence of a Master plan	0.23	0.54	0.84	0.36
Management structures	Total number of secretaries	2.56	2.84	2.41	2.97
Interfederative arrangements	Public partnership dimensions	2.48	0.00	2.63	0.03
	Intramunicipal partnership	1.00	0.00	0.92	0.00
	State partnership	0.01	0.00	0.23	0.00
	Federal partnership	0.00	0.00	0.02	0.00
Institutional participation channels	Total number of public councils	8.56	8.63	9.28	7.49
Internal and external control mechanisms	Existence of internal control institution	0.92	0.92	0.99	0.87
	Internal control institution is autonomous	0.65	0.75	0.94	0.68
	Existence of transparency council	0.01	0.01	0.01	0.00
Control variables	Gross domestic product per capita	$4,342.00	$4,887.65	$5,947.45	$2,742.08
	Municipal Human Development Index	0.66	0.66	0.69	0.60
	Total population	15,574.01	79,140.56	46,027.39	16,543.36

Cluster 3 (Average) has good results with regard to infrastructure and e-services, as well as regular responses to digital inclusion and e-transparency. It has an average population of 27,369, $4,240 in receipts per capita, and an M-HDI of 0.651. Furthermore, it has a more prominent presence in the Southeast and Northeast regions.

Cluster 4 (Behind) is the smallest cluster, with 454 municipalities, showing the worst results in all dimensions. This cluster comprises small cities in the Northeast and North regions. It has an average population of 15,834 as well as $1,394 in receipts per capita, $2,526 in GDP per capita, and an M-HDI of 0.601.

The cluster analysis of state capacity dimensions also resulted in four groups of municipalities (Table 4). Cluster A (Lagged) has high responses regarding human resources and contradictory responses regarding financial resources. Cluster B (Average) has the highest level of higher education and no interfederative arrangements. Cluster C (Advanced) has the best responses to the variables. Cluster D (Behind) has the worst responses to all dimensions.

Cluster A (Lagged) is the cluster with high human resources and statutory servants and the highest number of servants with middle school education. Although it has the highest receipt per capita, it has the second-highest dependence on federal transferences. It has fewer updated management tools but almost no land control through the director plan. Regarding interfederative arrangements, it has the highest number of public partnerships, majorly with other municipalities, almost none with states, and none with the federal government. As for internal and external control, almost all clusters have internal control, with more than 60% being autonomous or under the Executive office and almost none with a transparency council. The cluster has an average GDP of $4,326, an M-HDI of 0.658, and an average population of 15,574, with a presence in the

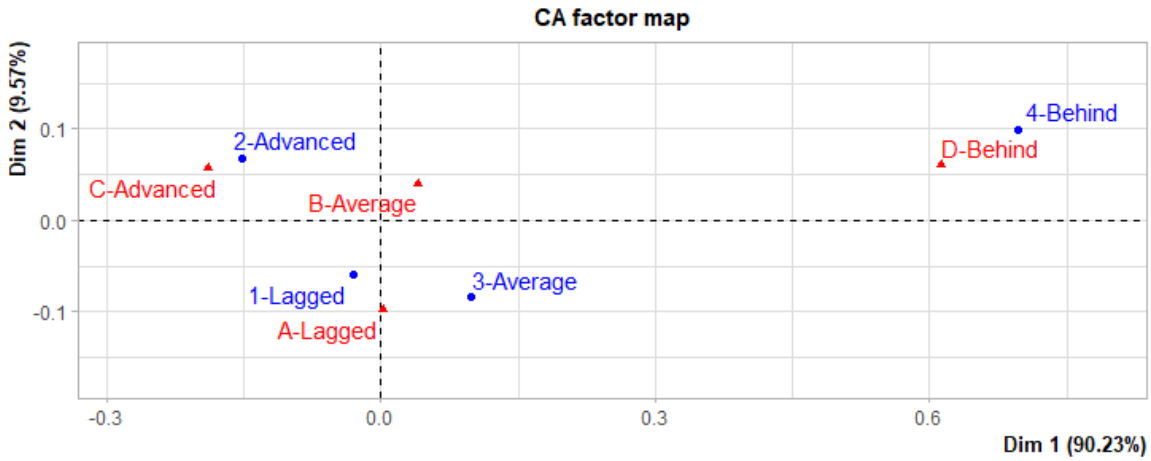

Figure 1: Perceptual Map of the Association between ICT Usage and State Capacity

Southeast and Center-West regions, composed mainly of small and medium-sized municipalities.

Cluster B (Average) has lower human resources, statutory servants, and the highest level of higher education. Regarding financial resources, it has the second-lowest receipt per capita and federal dependence, and charges an average amount of taxes and IPTU. Management tools has an average of updated tools; half of the group has a director plan. This cluster has zero public partnerships. As for internal and external control, almost all clusters have internal control, with more than 75% being autonomous or under the Executive office and almost none with a transparency council. The average GDP is $4,888, with an M-HDI of 0.663 and an average population of 79,140. It is the cluster with most larger cities, with a higher presence in the North, Northeast and Southeast regions.

Cluster C (Advanced) has the lowest human resources, the second-highest statutory servants, and higher education. It charges higher taxes, with all cities charging IPTU and having the lowest federal dependence. This cluster has the highest response regarding all variables in management tools and interfederative arrangements, being the only cluster with public partnerships with the federal government. It has the highest number of public councils, and virtually all cities have internal control institutions and are autonomous. This cluster has $5,947 in GDP per capita, an M-HDI of 0.691, and an average population of 46,027. It has a more significant presence in the South and Southeast regions, consisting of big, medium-sized, and small cities.

Cluster D (Behind) has the highest human resources, the lowest percentage of statutory servants, and higher education. In financial resources, it charges the lowest amount of taxes, receipt per capita, and IPTU enforcement and has the highest dependence on federal transferences. It has the lowest response to management tools and interfederative arrangements dimensions, the lowest response to the existence of internal control, and no transparency council. The average GDP per capita is $2,742, with an M-HDI of 0.596 and an average population of 16,543, composed mainly of small cities mainly in the North and Northeast regions.

5 DISCUSSION

To implement and execute public policies, local governments must have state capacity, capable human resources, financial resources that are adequate for their needs, infrastructural resources in which to work, and stable and prosperous relations with other governments. They also need e-gov initiatives to improve and make work more efficient, making it more available to citizens and expanding transparency, and with more quality. This paper verified the relationship between e-gov and state capacity dimensions.

State capacity dimensions measure the capacity of governmental entities to execute public policies, given their resources [3]. The literature points out that municipalities suffer from many problems with human resources, finances, and the lack of planning [2, 4, 16, 27]. The results for state capacity clusters show the existence of regional inequality, as pointed out in ICT usage [22, 30, 36].

Clusters show a better response in variables for groups with a higher presence in the South and Southeast regions and the worst response in the North and Northeast regions.

Comparing the responses regarding financial resources, it can be observed that the amount of taxes enforced and IPTU have a significant weight in the prefecture income and the dependence on federal transferences. Human resources and director plans also seem to impact financial resources. Updating of the generic valuation can increase their income [4, 16]. The clusters showed a low variance in municipal plans, numbers of secretaries, and public councils, and also showed a lack of transparency councils. They all have a high presence of internal control mechanisms. However, the level of autonomy is more related to variables of human and financial resources. Public partnerships can be correlated with the presence of statutory servants, the number of public councils, and income per capita, which can point out that more participative municipalities have a more solid administration and public engagement [6].

The variables chosen have a high relation with GDP per capita, the M-HDI, and regional locations, where cities located in the wealthier parts of the country, mainly in the South and Southeast regions, can increase and strengthen their resources through investing those resources in public policies, new technologies or other management tools and equipment.

These results go in the same direction as those of ICT usage by municipalities [30, 32, 36], where a large percentage have high and average ICT usage and a small group with challenges implementing e-gov measures. The correspondence analysis reinforces these findings, where cities with higher ICT usage and state capacity have a higher association than those with lower indicators. This result can demonstrate not only the transversal role of the use of technology in e-gov activities but also its importance in other functions such as the planning, control, and execution of public policies [32].

The regional and size inequalities become clear when the association between 4-D (Behind) and 2-C (Advanced) is analyzed. The former comprises small cities in the North and Northeast regions with low responses to ICT usage and state capacity variables. They have low educated human, financial, structural, and ICT resources that impact their capacity to formulate and implement public policies. In comparison, 2-C (Advanced) comprises municipalities with the highest GDP and HDI, predominance in the South and Southeast regions, and a high-density population. They have the best responses to ICT usage and state capacity variables, which can point out that these cities have the tools and institutions needed for digital transformation [21]. The 1-A (Lagged) association comprises medium-sized and small prefectures with good responses to all variables but lacks better tools with which to increase their results. Cluster B (Average) has good ICT usage but does not have a differential in state capacity variables, being composed of the highest-population cities, and 3 (Average) is composed of cities with good ICT usage but falls short in state capacity variables.

Given state capacity's multidimensionality [3, 8, 10] and the inconsistency and complexity of digital transformation [12, 24], it is visible that municipal governments possess multiple bottlenecks in ICT implementation, just as in their management forms, with the use of institutional tools which make them more or less efficient and effective with their resources. State capacity and ICT usage are intertwined due to their transversal role in all public administration activities [32]. In this paper, we found a relationship between ICT usage and state capacity dimensions, especially in municipalities with concrete state capacity and ICT usage and those with more fragile dimensions. Although it cannot be verified if state capacity promotes digital transformation or vice versa, it was possible to verify that ICT usage is needed for financial and planning tools.

The main barrier found goes in the direction of other findings [36], where a small group of municipalities are far behind others in comparison to others. Their difficulties are not only in public policy execution but also in financial, human, and institutional resources needed to implement policies that they are obliged by law to execute [27]. In this regard, new research into the state capacity dimension needs to be conducted to verify if the barriers are due to the lack of financial resources, regional size, political leadership, or, as pointed out in the literature, a combination of these characteristics [4, 9, 10, 23, 30, 32].

6 CONCLUSION

This study aims to verify if Brazilian local governments with a better state capacity response have more solid ICT usage through clustering, correspondence analysis, and descriptive statistics techniques. This article shows that state capacity and ICT usage have a high relationship, and state capacity indicators can be used to measure e-gov in future research. Brazilian municipalities are divided into a large group of cities with high ICT usage and strong state capacity, a small group with low ICT usage and state capacity, and the remaining cities with some gaps in some dimensions but closer to the "best group."

The cluster results for both dimensions behave similarly, with a large group with the best indicators in the South and Southeast regions, a small group with the worst indicators in the North and Northeast regions, and the other cities with not-so-high indicators. Therefore, we find a challenge for the smallest and poorest municipalities to develop their digital transformation initiatives and public management tools and mechanisms. They need state and federal government aid due to a lack of financial and institutional resources.

A large proportion of Brazilian cities showed promising results and can improve their characteristics by deepening their digital transformation initiatives and increasing participation and the quality of public services. Since the 1998 Constitution promulgations, municipalities have earned new responsibilities that they have not been ready to take on. More than 30 years after this paradigm shift, municipalities have shown great capacity in using and implementing technological and institutional tools and mechanisms, considering the barriers, bottlenecks, and complexity of serving services in the local context. However, a new way of undertaking politics and administration is needed in the country in order to pull the municipalities behind and allow those with some capacity to continue improving. This change is a complex federative challenge for Brazil. Future studies should explore which state capacities are relevant to effectively implementing e-government at the local level, including case studies with the municipalities.

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