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IT Teams and Municipal Digital Services: A Transaction Cost Analysis Across Brazilian Municipalities

Equipo de TI y servicios digitales municipales: Un análisis de costes de transacción en municipios brasileños

Equipe de TI e serviços digitais municipais: Uma análise de custos de transação entre municípios brasileiros

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Abstract

Under what conditions does local IT governance remain consequential for municipal digital service capacity when higher levels of government increasingly supply shared digital infrastructure? Drawing on transaction cost theory (TCT) and the literature on digital state capacity, we examine how task specificity, platform substitutability, and organizational continuity condition the association between municipal IT arrangements (internal, outsourced, and mixed) and formal digital service provision. We use data on all 5,569 Brazilian municipalities across seven MUNIC waves (2004–2024), distinguish informational from transactional services, and combine between-effects, Poisson, reweighting, and longitudinal analyses. Mixed arrangements are associated with greater service capacity, particularly for transactional services that require localized administrative knowledge; we interpret this as a conditional association rather than evidence of a superior sourcing model. The unadjusted gap in digital services between municipalities with and without

dedicated IT teams fell from 2.28 to 0.54 index points (−76%) between 2012 and 2024, with convergence concentrated in informational services, alongside the expansion of federal digital platforms. Teams sustained for five years or more show an additional association with service capacity, compatible with organizational continuity but also with preexisting capacity. The findings suggest that, in federal systems, shared platforms can substitute for some local capabilities but not for those embedded in local administrative processes.

Keywords: IT governance, e-government, Brazilian municipalities, transaction cost theory, digital service capacity.

Resumen

¿En qué condiciones sigue siendo relevante la gobernanza local de TI para la capacidad municipal de servicios digitales cuando los niveles superiores de gobierno proveen, cada vez más, infraestructura digital compartida? Con base en la Teoría de los Costos de Transacción (TCT) y en la literatura sobre capacidad estatal digital, examinamos cómo la especificidad de las tareas, la sustituibilidad mediante plataformas y la continuidad organizacional condicionan la asociación entre los arreglos municipales de TI (internos, externalizados y mixtos) y la oferta formal de servicios digitales. Utilizamos datos de los 5.569 municipios brasileños en siete olas de la MUNIC (2004–2024), distinguimos servicios informacionales y transaccionales y combinamos modelos de efectos entre grupos, especificaciones de Poisson, reponderación y análisis longitudinales. Los arreglos mixtos se asocian con una mayor capacidad de servicios, especialmente en los servicios transaccionales que requieren conocimiento administrativo localizado; interpretamos este resultado como una asociación condicional y no como evidencia de un modelo de aprovisionamiento superior. La brecha no ajustada de servicios digitales entre municipios con y sin equipos dedicados de TI se redujo de 2,28 a 0,54 puntos del índice (−76 %) entre 2012 y 2024, con una convergencia concentrada en los servicios informacionales, en paralelo a la expansión de las plataformas digitales federales. Los equipos mantenidos durante cinco años o más presentan una asociación adicional con la capacidad de servicios, compatible con la continuidad organizacional, pero también con una capacidad preexistente. Los hallazgos sugieren que, en sistemas federales, las plataformas compartidas pueden sustituir algunas capacidades locales, pero no aquellas integradas en los procesos administrativos locales.

Palabras clave: gobernanza de TI, gobierno electrónico, municipios brasileños, teoría de los costos de transacción, capacidad de servicio digital.

Resumo

Em que condições a governança local de TI continua relevante para a capacidade municipal de serviços digitais quando níveis superiores de governo passam a oferecer, cada vez mais, infraestrutura digital compartilhada? Com base na Teoria dos Custos de Transação (TCT) e na literatura sobre capacidade estatal digital, examinamos como a especificidade das tarefas, a substituibilidade por plataformas e a continuidade organizacional condicionam a associação entre os arranjos municipais de TI (internos, terceirizados e mistos) e a oferta formal de serviços digitais. Utilizamos dados de todos os 5.569 municípios brasileiros em sete ondas da MUNIC (2004–2024), distinguimos serviços informacionais e transacionais e combinamos modelos between-effects, especificações Poisson, reponderação e análises longitudinais. Arranjos mistos estão associados a maior capacidade de serviços, especialmente em serviços transacionais que exigem conhecimento administrativo localizado; interpretamos esse resultado como uma associação condicional, e não como evidência de um modelo de contratação superior. A lacuna não ajustada de serviços digitais entre municípios com e sem equipes dedicadas de TI caiu de 2,28 para 0,54 ponto do índice (−76%) entre 2012 e 2024, com convergência concentrada nos serviços informacionais, em paralelo à expansão das plataformas digitais federais. Equipes mantidas por cinco anos ou mais apresentam associação adicional com a capacidade de serviços, compatível com a continuidade organizacional, mas também com capacidade preexistente. Os resultados sugerem que, em sistemas federativos, plataformas compartilhadas podem substituir algumas capacidades locais, mas não aquelas inseridas nos processos administrativos locais.

Palavras-chave: governança de TI, governo eletrônico, municípios brasileiros, teoria do custo de transação, capacidade de serviço digital.

IT Teams and Municipal Digital Services: A Transaction Cost Analysis Across Brazilian Municipalities

The decision about how to govern information technology (IT) functions—whether to build internal teams, contract external providers, or ado*p*t a hybrid configuration—is among the most consequential organizational choices local governments make in the digital era. Yet the empirical literature examining how these IT governance structures relate to the breadth of digital services delivered to citizens remains sparse. This gap is particularly acute at the subnational level in emerging economies and across extended time horizons (Gil-Garcia et

al., 2018). While existing cross-sectional studies capture valuable snapshots, they lack the longitudinal perspective required to understand whether and how governance arrangements are persistently associated with service capacity over time and whether these associations remain stable or are contingent on the broader digital infrastructure environment.

Accordingly, this study asks: Under what task and infrastructural conditions does local IT governance remain consequential for municipal digital service capacity? We address this question by examining how three conditions shape the association between municipal IT arrangements and formal digital service provision: the specificity of the task, the substitutability of local capabilities by shared higher-level platforms, and the continuity of the organization over time. In doing so, we connect transaction cost reasoning to the literature on state capacity, digital-era governance, and federalism. In federal systems, the central government can shape municipal capacity not only through fiscal transfers and regulation but also by supplying shared technological infrastructure (Arretche, 2012; Dunleavy et al., 2006).

We ground our research in transaction cost theory (TCT; Lacity & Willcocks, 1998; Williamson, 1985), which explains why the value of alternative governance structures should vary with the characteristics of the task. TCT posits that asset specificity and output uncertainty, two defining features of municipal IT functions, favor governance arrangements that internalize highly idiosyncratic and strategically sensitive activities. Applied to digital public services, this framework suggests that the relative value of internal, outsourced, and mixed (hybrid) arrangements should increase or decrease with the specificity and uncertainty of the services being governed. We examine these conditional expectations using a multi-estimator strategy. Finally, we employ institutional memory theory (Walsh & Ungson, 1991) not as a competing primary framework, but as a compatible interpretive lens to explain the long-term maturity gradient of these governance choices.

We examine all 5,569 Brazilian municipalities, which vary widely in institutional capacity, fiscal resources, and population size. Brazil provides substantial variation in IT governance configurations alongside a well-documented evolution of national digital policy. The country's policy trajectory—from the Fiscal Responsibility Law of 2000, which initially catalyzed voluntary digital transparency among administratively capable municipalities (Diniz et al., 2009; Kubota, 2024), to the Access to Information Law of 2011—provides a useful context for this analysis. This environment is well suited for examining how local IT arrangements correlate with formal digital capacity over a two-decade horizon.

Our analysis yields three primary findings that together qualify the conventional expectation of a general advantage associated with hybrid IT governance. First, mixed (hybrid) IT configurations, which combine internal civil servants with external contractors, are associated with greater formal digital service capacity, and this association is particularly pronounced for transactional services requiring localized administrative knowledge and coordination. Because more capable municipalities may be better able to sustain hybrid arrangements, we interpret this as a conditional association rather than the effect of choosing a particular sourcing model. Second, the digital service gap between municipalities with and without dedicated IT teams contracted by 76% in unadjusted terms between 2012 and 2024, alongside the expansion of federal digital platform programs. As standardized federal digital capabilities expanded, differences associated with local IT arrangements became increasingly concentrated in transactional services that are more difficult to standardize. Third, we document a five-year maturity threshold, in which municipalities maintaining IT teams for five or more years exhibit an additional association with formal service capacity, which may reflect preexisting capacity as well as continuity. Although this temporal pattern does not directly demonstrate organizational learning or institutional memory, it suggests that the relationship between governance arrangements and digital capacity may also depend on organizational continuity over time. Recent comparative and Brazilian evidence likewise emphasizes that local digital transformation is shaped by governance structures and broader administrative capacities rather than by technology alone (Kuhlmann et al., 2026; Lui et al., 2025).

This study makes three main contributions. First, it moves beyond the established comparison between insourcing and outsourcing by identifying the conditions under which hybrid IT governance is most strongly associated with digital service capacity. Rather than finding a uniform hybrid advantage across digital services, we show that the association is substantially stronger for transactional services, where localized administrative knowledge, coordination, and asset specificity make standardization more difficult. This task-level contingency refines the application of transaction cost theory to digital government by shifting attention from which governance arrangement performs best in general to when different governance arrangements matter most.

Second, the study identifies the expansion of higher-level digital platforms as a boundary condition for the relevance of local IT governance. As federal platforms expanded standardized digital capabilities, differences in informational service capacity between municipalities with and without dedicated IT teams narrowed substantially, while organizational differences

remained more consequential for transactional services. This pattern is consistent with the possibility that shared digital infrastructure substitutes for some forms of local organizational capacity, but that such substitution has limits where service delivery remains embedded in local administrative processes. For federal systems, this points to a channel through which the central government shapes municipal capacity by supplying technological infrastructure rather than resources or rules. Third, the study introduces a temporal dimension to the analysis of IT governance by documenting a five-year maturity threshold in the association between dedicated IT teams and formal digital service capacity. Interpreted cautiously, this pattern is consistent with the possibility that organizational continuity allows knowledge, routines, and relational capabilities to accumulate over time. Together with the study's 20-year coverage of all 5,569 Brazilian municipalities, these findings shift the debate from a static choice between internal and external provision toward a contingent understanding of how task characteristics, shared digital infrastructure, and organizational continuity shape the relevance of local IT governance.

Theoretical Framework and Hypotheses

Task Specificity and the Contingent Value of IT Governance

Transaction cost theory, developed by Williamson (1985) and extended to IT governance by Lacity and Willcocks (1998), provides the primary theoretical framework for this study. TCT asks why organizations choose to make, buy, or hybridize activities, and it identifies three transaction characteristics that determine which governance structure minimizes total costs: asset specificity, behavioral uncertainty, and transaction frequency.

Asset specificity refers to the degree to which investments lose value outside the current governance relationship. When assets are highly specific—tailored to a particular organizational context and difficult to redeploy—the party that makes the investment is exposed to appropriation risks if the relationship ends. In municipal IT, specificity takes several forms. Physical specificity arises from IT systems customized to local administrative workflows, hardware configurations, and network architectures that have limited redeployment value. Human capital specificity arises from the accumulated knowledge of staff who understand the municipality's administrative processes, data structures, interoperability requirements with state and federal systems, and citizen service patterns. Relational specificity arises from the trust, communication protocols, and shared understandings that develop between IT staff and departmental users over repeated interaction (Jacobides & Billinger, 2006; Lacity & Willcocks, 1998; Williamson, 1985).

Behavioral uncertainty refers to the difficulty of specifying, observing, and evaluating the performance of the other party to a transaction. In municipal IT, uncertainty is high across multiple dimensions. Output uncertainty is high because digital service quality resists complete contractual specification: citizen satisfaction, system reliability, response time, accessibility, and integration with other services involve professional discretion that cannot be fully codified in advance. Environmental uncertainty is high because technological standards change rapidly, citizen needs evolve, federal regulatory requirements shift, and the digital platform landscape is continuously restructured. Measurement uncertainty is high because IT performance depends on a combination of technical and organizational factors that are difficult to separate, making it difficult to attribute outcomes to vendor performance versus client behavior (Cordella & Willcocks, 2012; Williamson, 1985).

When asset specificity and uncertainty are simultaneously high, Williamson (1985) predicts that hierarchical governance—organizing the activity within the firm or agency through employment relationships—reduces total transaction costs relative to market contracting. The costs of writing complete contracts, monitoring vendor compliance, renegotiating when circumstances change, and resolving disputes ex post exceed the coordination costs of hierarchical authority. When transactions are instead standardized, and uncertainty is low, market procurement offers efficiency advantages through competition, specialization, and scale that hierarchy cannot match (Jacobides & Billinger, 2006; Lacity & Willcocks, 1998).

H_1: Municipalities with a dedicated IT team, regardless of arrangement type, are more likely to offer a broader range of formal basic digital services than municipalities without any dedicated IT team.

Lacity and Willcocks (1998) apply this framework empirically to IT outsourcing decisions, finding that selective outsourcing—retaining internal governance for strategic and asset-specific IT functions while contracting standardized commodity functions—consistently outperforms both total outsourcing and total insourcing on cost and performance criteria. Their analysis establishes that the key governance question is not a binary choice between make or buy but a decision about what to make, what to buy, and how to manage the interface. Organizations that retain internal capacity for the most idiosyncratic and strategically sensitive IT activities, while accessing external providers for volume, specialization, and commodity functions, capture the advantages of both governance modes.

Cordella and Willcocks (2012) extend this analysis to the public sector, documenting that government IT outsourcing faces additional institutional constraints that pure transaction cost minimization does not capture: democratic accountability requirements constrain what can be contracted; public value considerations shape which service attributes matter; and political cycles create governance instability that disrupts the long-term relationships on which effective IT outsourcing depends. Schomaker and Bauer (2022) further demonstrate empirically that trust deficits between public and private actors elevate transaction costs in public–private IT partnerships, reinforcing the TCT prediction that arrangements with an internal anchor reduce contractual hazards. Potoski (2026) advances TCT measurement in public contracting, validating that asset specificity and measurability—the core TCT constructs—are empirically tractable in government IT contexts. Clarke (2020) shows that the emergence of hybrid digital government units—organizational forms that blend internal civil service expertise with external technical partnerships—represents a practical institutional response to these constraints. Those units seek governance models that preserve public accountability while accessing the technical capabilities and scale that internal government IT often lacks.

H2a: Arrangements that retain internal IT knowledge (internal-only and mixed) are more likely than outsourced-only arrangements to be associated with greater formal basic digital service capacity.

These arguments imply that the relevance of IT governance arrangements should not be uniform across digital services. Informational services, such as publishing information and providing downloadable forms, involve comparatively standardized outputs and limited integration with idiosyncratic administrative processes. Transactional services, by contrast, require greater coordination with local workflows, data structures, procurement routines, and citizen-facing administrative processes. They therefore involve greater asset specificity and behavioral uncertainty. From a TCT perspective, the organizational advantages associated with retaining internal knowledge and combining it with external technical expertise should consequently be more pronounced for transactional than for informational services. The relevant theoretical question is thus not simply which governance arrangement performs best, but under which task conditions differences among governance arrangements become most consequential. We therefore expect the complementarity of mixed arrangements to matter most where tasks are least standardizable. Recent evidence also identifies institutional and organizational barriers as a recurrent challenge in public-sector digital transformation (Figueredo & Silva, 2026).

H2b: The advantage associated with mixed IT arrangements increases with task specificity: it is expected to be larger for transactional services, which require coordination with local administrative processes, than for informational services, which are more standardized.

Shared Digital Infrastructure, Federalism, and Platform Substitutability

State capacity is usually conceived as a stock of resources, skills, and organizational structures held by a given government. Digital-era governance, however, relocates part of that capacity into shared infrastructure that can serve many organizations at once (Dunleavy et al., 2006; Margetts & Dunleavy, 2013). In federal systems, this creates a channel through which the central government shapes subnational capacity without transferring funds or imposing rules: by providing platforms that change the production function of local government (O'Reilly, 2011). This resembles what Mann (1984) called infrastructural power, the capacity of the state to penetrate and coordinate action across its territory.

In Brazil, where municipalities hold broad service responsibilities but have highly unequal administrative capacities (Arretche, 2012; Grin et al., 2021), federal digital platforms may therefore act as a capacity equalizer. This equalization should be selective. Platforms can supply standardizable capabilities, such as publishing information or processing access-to-information requests, but not capabilities embedded in local procurement, protocol, and grievance processes. Combining this argument with TCT yields the expectation that local IT governance remains consequential precisely where shared infrastructure cannot substitute for local knowledge.

A critical question for any TCT analysis of IT arrangements is whether its predictions are temporally stable or contingent on the broader technology environment. The platform governance literature suggests a boundary condition: as higher-level digital platforms mature and achieve infrastructural reach, they reduce the local organizational requirements for baseline digital service provision (Haug et al., 2024). Digital public infrastructure similarly emphasizes foundational capabilities that organizations and levels of government can share rather than reproduce locally (Bauer et al., 2025), while comparative evidence shows that multilevel governance structures strongly condition local digital transformation (Kuhlmann et al., 2026). When a federal platform provides standardized digital capabilities that municipalities can access without building equivalent local capacity, the marginal transaction cost advantage of internal IT governance at the informational service tier diminishes (OECD, 2024, 2026; OECD/IDB, 2024). Platform infrastructure therefore changes the transaction-cost environment itself. Capabilities that

once required local organizational investment may become standardized external resources, shifting the domains in which local governance arrangements remain consequential.

In the Brazilian context, four federal milestones are associated with this equalization dynamic: the Federal E-Government Program (2000), the Access to Information Law (2011), the e-SIC (2012) platform, and the GOV.BR portal (2019). We predict that as these platforms matured, the formal digital service gap between municipalities with and without IT teams narrowed, but unevenly across digital service types: informational and transactional. Standardized platforms can most fully substitute for local capacity, helping equalize basic informational digital services. However, transactional digital services require coordination on interoperability, citizen data management, and integration with local administrative processes. Centralized platforms can only partially standardize these requirements, as they are tied to specific municipal contexts. Therefore, we propose the following hypothesis:

H_3: As federal digital platforms expand, the formal digital service gap between municipalities with and without IT teams is expected to narrow, more strongly for basic informational than for basic transactional services.

Organizational Continuity and Institutional Memory

Transaction cost theory explains why governance arrangements may differ in their capacity to manage asset specificity and uncertainty, but the effectiveness of a governance structure may also depend on the organizational history through which it operates. Institutional memory theory (Walsh & Ungson, 1991) provides a complementary lens for understanding this temporal dimension. Organizations retain knowledge through individual expertise, routines, procedures, cultural understandings, and relational experience. In municipal IT governance, continuity may allow employees to accumulate knowledge of administrative processes, while repeated interaction among public employees, external providers, and service departments may generate shared routines, communication protocols, and relational knowledge that reduce future coordination costs.

This temporal perspective also connects to absorptive capacity (Cohen & Levinthal, 1990). Internal IT capacity may enable municipalities not only to retain context-specific knowledge but also to evaluate, assimilate, and productively use specialized expertise obtained from external providers. In mixed arrangements, therefore, continuity may strengthen the interface between internal institutional knowledge and external technical capabilities. Relational history

may also affect trust and reliability: repeated productive interactions can reduce monitoring and coordination costs, whereas unstable relationships or repeated personnel turnover may prevent such capabilities from consolidating. We treat these mechanisms as interpretive rather than directly tested explanations. MUNIC identifies the presence and configuration of IT teams but does not measure employee motivation, organizational culture, interpersonal trust, contractual quality, team integration, or the routines through which knowledge is retained. Consequently, any maturity pattern observed in the data should be interpreted as compatible with institutional memory and relational accumulation, rather than as direct evidence of these mechanisms. Alternative explanations, including survivor bias and administrative sorting, remain possible. In particular, duration may be endogenous to capacity: municipalities able to sustain a team for several years may be structurally more capable.

H_4: Conditional on having adopted a dedicated IT team, municipalities that sustain it for five years or more are more likely to show greater formal digital service capacity than municipalities with more recently established teams.

Case Selection, Data, Variables, and Research Design

This study tests the hypotheses using all Brazilian municipalities as the research setting. Brazil's 5,569 local governments span a broad range of institutional capacities, fiscal resources, and population sizes, providing substantial variation in IT governance configurations alongside a well-documented evolution of national digital policy. The policy trajectory from the Fiscal Responsibility Law of 2000, which initially catalyzed voluntary digital transparency among administratively capable municipalities (Diniz et al., 2009; Kubota, 2024), to the Access to Information Law of 2011 provides a useful context for this analysis. At the federal level, coordination and support for municipal digital transformation are primarily led by the Digital Government Secretariat [Secretaria de Governo Digital] (SGD), within the Ministry of Management and Innovation in Public Services [Ministério da Gestão e da Inovação em Serviços Públicos] (MGI). The SGD is responsible for promoting national digital government policies, developing shared digital infrastructure and platforms, and supporting subnational governments in the expansion and modernization of digital public service provision.

Moreover, in 2012, the federal government adopted a digital platform that sought to equalize access to digital services across all municipalities over successive policy cycles. The e-SIC—Electronic System for Citizen Information Service [Sistema Eletrônico do Serviço de Informação ao Cidadão]—was established in 2012 to provide a standardized online portal

through which any citizen can submit, track, and receive responses to public information requests, making formal digital citizen–government interaction accessible to all municipalities regardless of local IT capacity. GOV.BR, launched in 2019, consolidated access to federal public services under a single authenticated digital ecosystem. By 2025, the platform registered over 170 million users (80% of the Brazilian population), brought together more than 4,500 federal digital services, and extended integration to 16 states, providing municipalities with a universally accessible catalog of formal digital services that requires no local organizational investment to access. These platforms constitute the federal digital infrastructure whose successive rollouts are temporally aligned with the platform equalization pattern documented in this study.

Data and Dependent Variable

The empirical analysis draws on MUNIC (Basic Municipal Information Survey), conducted by IBGE across all 5,569 Brazilian municipalities in seven waves: 2004, 2006, 2009, 2012, 2014, 2019, and 2024 (N = 38,983 municipality-year observations). The Digital Services Index (DSI; range: 0–5) measures the formal nominal availability of five basic e-government functions: (1) informational services and local news; (2) online access to documents and forms; (3) electronic bidding participation; (4) protocol tracking; and (5) citizen grievance channels. Each item is binary. The informational service subindex (0–2) aggregates items 1–2; the transactional service subindex (0–3) aggregates items 3–5. “Transactional” denotes basic interactive exchange, such as electronic bidding, protocol tracking, and grievance submission, rather than advanced digital integration or automation (OECD/IDB, 2024). All measures capture formal supply-side provision capacity, not service quality, usage, or citizen adoption.

The MUNIC definition of a dedicated IT team changed in 2019, when the questionnaire adopted a stricter criterion. As a result, the number of municipalities classified as having no IT team rose from 900 in 2014 to 2,379 in 2019. Comparisons across the 2014–2019 break are therefore interpreted with caution.

Figure 1

Proportion of Municipalities with a Dedicated IT Team



Note. Source: MUNIC/IBGE (2004–2024). Shading indicates the proportion of municipalities with any dedicated IT team per state (light = low prevalence; dark = high prevalence).

Figure 1 shows the evolution of the presence of dedicated IT teams over the study period. In 2004, dedicated IT teams were concentrated in the South and Southeast and nearly absent in the North and Northeast. Between 2006 and 2014, adoption expanded progressively across all regions, peaking when more than 80% of southern municipalities had already dedicated IT capacity. The sharp drop in 2019 is a measurement artifact: the MUNIC questionnaire adopted a stricter definition of “IT team” in that edition, rather than reflecting the actual dissolution of teams. By 2024, prevalence had partially recovered but remained below 2014 levels, partly because the new criterion was more demanding and possibly because federal platforms such as GOV.BR reduced the need for autonomous local IT structures to offer basic digital services, a possibility we treat as a hypothesis rather than a finding. The north-south gradient persists throughout, but is visibly narrower in 2024 than in 2004, a pattern consistent with, but not proof of, the equalizing reach of federal digital infrastructure across historically more vulnerable regions.

Between 2019 and 2024, when the definition is homogeneous, state-level trajectories diverged. The share of municipalities with a dedicated IT team fell in several North and Northeast states, such as Piauí (from 42% to 29%), Ceará (from 57% to 47%), and Pará (from

60% to 51%), and rose in others, such as Tocantins (from 39% to 50%) and Espírito Santo (from 76% to 85%). These movements may reflect changes in sourcing strategies, in municipal capacity, or in the broader technological environment.

Key Predictors and Controls

For the seven-wave Layer 1 analysis, the primary predictor is a binary indicator of IT team presence. For the two-wave Layer 2 analysis, MUNIC 2019 and 2024 provide four mutually exclusive categories: No IT Team (reference category), Internal Only, Outsourced Only, and Mixed. IT arrangements are operationalized through binary variables for data center existence and in-house software development. Partnership Breadth is an additive index (0–5) across five partner types. All models control for log (population), civil servants per 1,000 inhabitants, and log (GDP per capita). Model M3 in Layer 1 adds two political controls from the Superior Electoral Court (TSE), both referring to the mayor. Reelection status captures the incumbent's time horizon and administrative continuity, because reelected mayors may be more willing to invest in IT capacity whose returns extend beyond one term. Educational attainment (higher-education degree) proxies managerial capacity at the top of the executive.

Estimation Strategy

The primary specification uses the between-effects estimator, which uses municipality-level means over time, to describe persistent cross-sectional differences in IT governance arrangements and formal basic digital service capacity. This answers the TCT-motivated question: Which municipalities show stronger associations between governance arrangement type and formal service portfolios? The Hausman test ($\chi^2(10) = 40.909$, $p < .001$) rejects random effects (Appendix Table A1). We retain between-effects estimation as the primary estimator because our question concerns persistent cross-municipal differences; fixed-effects estimates, reported in Table A1, also show a positive and significant association for mixed arrangements. All variance inflation factors (VIFs) fall below 3.0. Poisson generalized linear models (GLMs) complement ordinary least squares (OLS) for all Layer 2 specifications, reporting incidence rate ratios (IRRs). Large proportional ratios in some specifications reflect the near-zero baseline of never-treated municipalities in early waves and are contextualized accordingly.

Two-way fixed-effects (TWFE) models document how formal basic digital service capacity evolves relative to IT team adoption timing. The event study constructs relative-time bins from the year the team was established and time to treatment. Significant positive pre-adoption

trends demonstrate that the parallel trends assumption fails, precluding causal interpretation (Roth et al., 2023; Sun & Abraham, 2021). These are descriptive longitudinal patterns. The maturity analysis tests whether post-adoption patterns reflect a discrete threshold at 5 and 10 years of operation. Event study plots are in Appendix Figure A1. Cohort-specific comparisons using only the 237 never-treated municipalities as controls avoid the forbidden-comparisons problem in standard TWFE (Goodman-Bacon, 2021) and provide additional descriptive triangulation (Callaway & Sant'Anna, 2021). The appendix reports the Hausman test and VIF diagnostics (Table A1), inverse probability weighted (IPW) OLS estimates (Table A2), Mundlak–Poisson estimates (Table A3), federal policy milestones (Table A4), and the full Poisson specification (Table A5).

Three methodological commitments frame our analysis throughout. First, the dependent variable captures the formal, supply-side provision of five basic e-government functions, rather than service quality, backend integration, or citizen adoption. Second, all reported estimates represent structural associations derived from observational data, not causal treatment effects. Third, significant pre-adoption trends in our event study indicate positive selection regarding prior administrative capacity, further precluding a strictly causal interpretation of the longitudinal patterns.

Results

Descriptive Overview

Table 1 presents descriptive statistics stratified by IT team arrangement (pooled 2019 and 2024; N = 11,138). The mean DSI is 3.73 (SD = 1.25). Municipalities with mixed arrangements average 0.84 DSI points higher than those with no IT team (4.25 vs. 3.41) but also differ substantially in size, wealth, and technical endowment, which motivates multivariate controls. In 2019, 42.7% of municipalities had no dedicated IT team; by 2024, mixed arrangements had grown to 22.1%. In 2004, 100% of municipalities without IT teams scored zero on the DSI; formal basic digital service provision was at that point almost exclusively associated with dedicated IT capacity.

Table 1

Descriptive Statistics by IT Team Arrangement (Pooled 2019 and 2024; N = 11,138)

Variable	No IT Team (n = 4,737)	Internal Only (n = 1,218)	Outsourced Only (n = 2,857)	Mixed (n = 2,326)	Full Sample
DSI Total (0–5)	3.408	3.869	3.776	4.247	3.728 (1.249)
Informational (0–2)	1.504	1.681	1.641	1.776	1.615 (0.615)
Transactional (0–3)	1.903	2.189	2.135	2.471	2.113 (0.841)
Data Center (CPD)	0.217	0.658	0.597	0.835	0.492 (0.500)
In-House Software Dev.	0.120	0.196	0.215	0.394	0.210 (0.407)
Partnership Breadth	0.402	0.529	0.597	0.766	0.542 (0.712)
Log (Population)	9.034	9.389	9.346	10.491	9.457 (1.181)
Log (GDP per capita)	9.857	10.270	10.130	10.459	10.098 (0.753)
Civil Servants/1,000	36.85	35.69	35.62	32.67	35.54 (23.37)

*Note. Cell values are group means; the full-sample column reports the mean (*SD*). Unadjusted differences are confounded by size, wealth, and technical endowment; see multivariate models below.*

IT Team Arrangement and Formal Digital Service Capacity

Tables 2, 3, and 4 present the primary results. Across all estimators, the pattern is consistent with the conditional expectations derived from TCT: IT team presence is associated with substantially more formal basic digital service capacity (H_1); arrangements retaining internal knowledge are associated with greater capacity than outsourced-only arrangements (H2a); and the association for mixed arrangements is larger for basic transactional services (H2b). Table 2 presents three progressive specifications that reveal the trade-off between temporal coverage and covariate richness. M1 (baseline, 2004–2024) covers all seven waves with minimal controls, excluding GDP per capita because it is unavailable before 2014. M2 (economic controls, 2014–2024) adds GDP per capita but restricts the sample to the three most recent waves; the smaller IT Team Present coefficient (β = 0.866 vs. 2.295) reflects this compressed post-equalization window rather than a weakening of the association. M3 (*p*olitical controls, 2006–2024) adds mayoral reelection status and educational attainment available from 2006 onward (both coefficients are reported in Table 2), yielding a coefficient (β = 2.049) close to M1. Across all three specifications, the IT Team Present coefficient is positive, large, and significant at $p < .001$, providing consistent evidence for H_1.

Table 2

Between-Effects Estimates — Layer 1: IT Team Presence (2004–2024)

Variable	M1 (2004–2024): Baseline	M2 (2014–2024): Economic controls	M3 (2006–2024): Political controls
IT Team Present	2.295***	0.866***	2.049***
Log (Population)	0.054*	0.116***	0.090***
Log (GDP per capita)	—	0.367***	—
Civil Servants per 1,000	−0.008**	−0.005***	−0.007**
Mayor reelected	—	—	0.158***
Mayor with higher education	—	—	0.183***
N municipalities	5,569	5,569	5,569
R^2	0.358	0.300	0.468

Note. Between-effects OLS. Dependent variable: Digital Services Index (DSI; 0–5). HC3 robust SEs. Political controls (M3) refer to the mayor (source: TSE). Coefficients are structural associations. *p < *.05,* **p < *.01,* ***p < *.001.*

Table 3 (Layer 2) shows the arrangement-type ordering consistent with H2a across all specifications. Internal Only is associated with 0.220 additional DSI points ($p < .001$; IRR = 1.061); Outsourced Only with 0.146 additional DSI points ($p < .001$; IRR = 1.047); Mixed with 0.407 additional DSI points ($p < .001$; IRR = 1.093). The internal–outsourced gap (0.074 points) persists after controlling for data center and software development, consistent with TCT's prediction that governance arrangement captures organizational value beyond technical infrastructure. This ordering aligns with earlier research on selective IT outsourcing while extending that pattern to municipal digital service portfolios. It also resonates with recent Brazilian evidence that local digital transformation varies with fiscal, human-resource, and technical-administrative capacities (Lui et al., 2025). Because more capable municipalities may be better able to sustain hybrid arrangements, these estimates are conditional associations rather than effects of choosing a sourcing model.

Table 3

Between-Effects Estimates — Layer 2: IT Team Type (2019 and 2024)

Variable	Total DSI M1	Total DSI M2	Total DSI M3	Informational Services M3	Transactional Services M3
Internal Only	0.330***	0.240***	0.220***	0.115***	0.106**
Outsourced Only	0.271***	0.170***	0.146***	0.079***	0.067*
Mixed	0.587***	0.432***	0.407***	0.155***	0.252***
Data Center (CPD)	—	0.238***	0.228***	0.045*	0.183***
In-House Software Dev.	—	0.200***	0.190***	0.079***	0.111***
Partnership Breadth	—	—	0.164***	0.105***	0.059*
Federal Partnership	—	—	−0.050	−0.031	−0.019
Private Partnership	—	—	0.107	−0.036	0.143**
Log (Population)	0.085***	0.052***	0.041**	0.000	0.041***
Log (GDP per capita)	0.323***	0.284***	0.268***	0.084***	0.185***
Civil Servants per 1,000	−0.004**	−0.004**	−0.004†	−0.003**	−0.001
N municipalities	5,569	5,569	5,569	5,569	5,569
R^2	0.169	0.182	0.188	0.093	0.191

*Note. Between-effects OLS. Reference category: No IT Team. DSI = Digital Services Index; M1 = socioeconomic controls; M2 adds IT infrastructure; M3 is the full model. HC3 robust SEs. Coefficients are structural associations. †p < .10, *p < .05, **p < .01, ***p < .001.*

The Mixed association is larger at the basic transactional tier (β = 0.252; IRR = 1.106) than at the informational tier (β = 0.155; IRR = 1.076). Transactional services are the service type for which asset specificity and output uncertainty, and therefore the TCT-predicted advantage of mixed governance, are highest. IPW-weighted estimates (β = 0.363, p = .008; Appendix Table A2) confirm that the pattern persists after reweighting on six observable confounders. The Mundlak–Poisson results (Appendix Table A3) show mixed retaining significance (IRR = 1.042 total; IRR = 1.056 transactional), while the association for Internal Only attenuates, indicating that the Internal Only association is more sensitive to stable municipality characteristics. The non-significance of Federal Partnership across all specifications is consistent with H_3: federal digital platforms may have become sufficiently universal that a formal federal partnership confers no additional formal service advantage. The stronger association for transactional services is also consistent with recent research emphasizing that digital transformation depends on organizational capacity and the integration of technology with administrative processes, not simply on technology availability (Figueredo & Silva, 2026; Gasco-Hernandez, 2024).

Because the two subindices have different ranges (0–2 and 0–3), their raw coefficients are not directly comparable. The Poisson incidence rate ratios, which express associations in proportional terms, point in the same direction (Mixed: IRR = 1.106 for transactional and 1.076 for informational services; Appendix Table A5), although the difference is modest. The task gradient is specific to Mixed arrangements: Internal Only (0.115 vs. 0.106) and Outsourced Only (0.079 vs. 0.067) show similar associations across service types. This suggests that it is the combination of internal and external capabilities, rather than internal capacity per se, whose value rises with task specificity (H2b).

Platform Equalization: A Boundary Condition on the TCT Associations

Table 4 documents the year-by-year formal digital service gap between municipalities with and without IT teams, defined as the absolute difference in unadjusted mean DSI between the two groups in each wave. The gap peaked at +2.28 index points in 2012 and contracted to +0.54 in 2024, a 76% reduction over 12 years ((2.284 − 0.541) / 2.284), while both groups continued expanding their formal digital portfolios. This contraction is temporally aligned with three federal policy milestones: the Access to Information Law (2011), the e-SIC platform (2012), and the GOV.BR portal (2019). We interpret this as a boundary condition on the TCT findings: the pattern is consistent with federal platforms reducing the organizational requirements for baseline formal digital service provision, compressing the informational-tier gap while leaving the transactional-tier association more intact, although our design does not isolate that mechanism.

Table 4

Platform Equalization: Formal Digital Service Gap by Wave (2004–2024)

Year	Mean - with IT team	Mean - no IT team	Gap	N (with IT team)	N (without IT team)
2004	1.363	0.000	+1.363	2,162	3,397
2006	1.943	0.119	+1.824	2,385	3,178
2009	2.005	0.292	+1.713	2,840	2,724
2012	2.579	0.294	+2.284	3,883	1,681
2014	2.762	0.550	+2.212	4,669	900
2019	3.790	3.220	+0.570	3,190	2,379
2024	4.139	3.597	+0.541	3,211	2,358

Note. Five-item longitudinal DSI (0–5). Unadjusted means. Gap = absolute difference between group means. The 76% contraction from the 2012 peak is temporally aligned with the Access to Information Law (2011), e-SIC/INDA (2012), and GOV.BR (2019). Other contemporaneous factors may contribute.

Most of this contraction occurred between 2014 and 2019, when the MUNIC questionnaire adopted a stricter definition of a dedicated IT team and the no-team group grew from 900 to 2,379 municipalities. Part of the convergence may therefore reflect reclassification rather than change in service provision. Within the two definitionally homogeneous periods, Table 4 shows that the gap changed little: from +2.284 in 2012 to +2.212 in 2014, and from +0.570 in 2019 to +0.541 in 2024. The magnitude of the 76% contraction should therefore be read with caution; the more robust part of the finding is the differential pattern across service types discussed below.

The tier-specificity is consistent with H_3. At the informational tier, convergence is near-complete by 2024: municipalities without IT teams averaged 0.00 informational services in 2004 and 1.68 in 2024 (gap: 0.10 points). The basic transactional tier retains a larger association: mixed teams show β = 0.252 for transactional services in the fully specified between-effects model, compared to β = 0.155 for informational, consistent with the prediction that services requiring local administrative process integration resist standardization by federal platforms. This selective convergence is consistent with the broader logic of shared digital infrastructure: standardized foundational capabilities can be supplied across jurisdictions, while locally embedded transactional processes continue to require organizational coordination and context-specific knowledge (Bauer et al., 2025).

Longitudinal Patterns and Maturity Gradient

The event study (Appendix Figure A1) documents significant positive pre-adoption trends (β = 0.342 at 10–15 years and β = 0.714 at 15 or more years before adoption) demonstrating positive selection on administrative capacity that precludes causal interpretation of post-adoption patterns. After adoption, the TWFE model shows large positive associations for total DSI at onset (β = 1.093) and similar ones at +6 to +10 years (β = 1.026), so no monotonic increase is implied; for basic transactional services, the association rises from β = 0.297 (+1 to +5 years) to β = 0.446 (+6 to +10 years). A dip at −2 to −4 years (β = −0.211) precedes adoption, consistent with a reorganization period.

Table 5 (Panel A) shows that the maturity gradient is not linear: the coefficient on years since adoption is non-significant (β = −0.005, p = .272), while a discrete positive pattern emerges at five or more years of operation (β = 0.190, p < .001). This threshold pattern is compatible with institutional memory theory—knowledge consolidating into productive routines over multiple years—but equally compatible with survivor bias and administrative sorting.

This pattern is consistent with H_4, although, as with H_1–H_4, it reflects a structural association rather than a causal effect of organizational tenure. Table 5 (Panel B) reports cohort-specific comparisons against the 237 never-treated municipalities, showing consistent patterns across 2006–2014 cohorts (range: 1.454 to 1.887) with a weighted average of 1.613, closely aligned with the TWFE estimate of 1.204.

Table 5

Maturity Pattern (Panel A) and Cohort Comparisons (Panel B)

Panel A — Maturity Analysis (TWFE, 7 waves)	**β**		***SE***		***p***
IT team adopted (onset)	1.204***		0.022		< .001
Linear age (years since adoption)	−0.005		0.005		.272
Five-year threshold (≥ 5 years)	0.190***		0.026		< .001
Ten-year threshold (≥ 10 years)	0.054		0.031		.081
R^2-within / N	0.635 / 38,913		-		-
Panel B — Cohort Comparisons (Callaway-Sant'Anna framework)	*N*o. of adopters	Total Digital Services Index	*SE*	Transactional Services	*SE*
2006 (2004→2006)	887	1.634***	0.040	0.488***	0.026
2009 (2006→2009)	727	1.454***	0.050	0.444***	0.031
2012 (2009→2012)	692	1.855***	0.055	0.733***	0.036
2014 (2012→2014)	618	1.887***	0.079	0.818***	0.049
2019 (2014→2019)	173	0.236	0.163	0.069	0.102
Weighted average	-	1.613	-	0.575	

*Note. Panel A: TWFE with municipal and wave FE, clustered SEs. Panel B: 2 × 2 comparisons vs. never-treated (*N = *237); descriptive patterns only.* ***p < *.001.*

Because the maturity model includes municipality fixed effects, time-invariant differences in capacity are absorbed. The remaining concern is time-varying capacity: municipalities on improving trajectories may be those that sustain their teams. We therefore interpret the threshold as capturing organizational stability, which may reflect preexisting capacity as much as continuity itself.

Discussion

The central finding of this study is not simply that mixed IT arrangements are associated with broader digital service capacity than purely internal or outsourced arrangements. Such a ranking is broadly consistent with established research on selective IT outsourcing (Lacity & Willcocks, 1998). The more theoretically informative finding is that this advantage is not uniform across digital tasks. Mixed arrangements exhibit a stronger association with tran-

sactional services (β = 0.252) than with informational services (β = 0.155; see also the incidence rate ratios in Appendix Table A5), indicating that the relevance of governance structure increases where digital service delivery depends more heavily on localized administrative knowledge, coordination, and process integration. The findings therefore shift the analytical emphasis from whether hybrid governance performs better in general to the conditions under which its organizational advantages become most consequential.

From Hybrid Advantage to Contingent Hybrid Governance

This task-level heterogeneity refines the application of transaction cost theory to digital government. Informational services are comparatively amenable to standardization: publishing information, providing forms, and maintaining basic online access require less integration with idiosyncratic administrative processes. Transactional services such as electronic bidding, protocol tracking, and grievance channels are more deeply embedded in local workflows, data structures, legal procedures, and interdepartmental coordination. These characteristics increase asset specificity and behavioral uncertainty, precisely the conditions under which purely contractual governance becomes more difficult and retaining internal organizational knowledge becomes more valuable.

Mixed arrangements appear particularly well positioned under these conditions because they combine two forms of capacity that are difficult to maximize simultaneously. Internal personnel retain contextual knowledge of administrative processes, legal requirements, organizational routines, and user needs, while external providers offer specialized expertise, technological updating, and scale. The relevant contribution is therefore not a universal claim that hybrid governance is the optimal organizational form. Rather, the findings suggest a contingent hybrid advantage: the relative value of combining internal and external capabilities increases as service delivery becomes more organizationally specific and less amenable to standardization. Recent evidence from Brazilian municipalities likewise shows that digital maturity is embedded in broader fiscal, human-resource, and structural capacities (Lui et al., 2025).

This interpretation also requires caution about the direction of the relationship. More capable municipalities may be precisely those able to sustain hybrid arrangements, so the mixed association may partly reflect selection or reverse causation. The evidence identifies conditional associations: hybrid arrangements are associated with greater capacity, particularly when tasks require a combination of external resources and internal organizational knowledge, not a causal effect of choosing a particular sourcing arrangement.

The robustness pattern reinforces this interpretation while also requiring caution. The association for internal-only arrangements attenuates to non-significance in the Mundlak–Poisson specification, whereas the mixed association persists after accounting for stable municipality-level heterogeneity. This pattern is consistent with the complementarity argument underlying selective outsourcing and recent work on insourcing (Petersen, 2024), but it does not identify the underlying mechanisms causally. The data observe governance configurations and formal service capacity, not contractual exposure, vendor monitoring, strategic alignment, or the actual integration of internal and external expertise. Thus, the findings provide evidence consistent with TCT mechanisms rather than direct tests of those mechanisms.

Platform Equalization and the Changing Value of Local Capacity

The second contribution concerns how the broader digital infrastructure environment changes the relevance of local governance arrangements. Between 2012 and 2024, the formal digital service gap between municipalities with and without dedicated IT teams contracted 76% in unadjusted terms, alongside the expansion of federal digital platforms and standardized digital capabilities. This convergence was concentrated in informational services rather than transactional services. The pattern is consistent with the possibility that higher-level digital infrastructure substitutes for some forms of local organizational capacity, but that this substitutability depends on the characteristics of the service being provided.

Our evidence documents convergence; it does not isolate substitution. The narrowing of the gap is temporally aligned with the Access to Information Law, the e-SIC platform, and GOV.BR and is concentrated in the informational services those initiatives most directly standardize. Other processes may contribute to the same pattern: the diffusion of standardized software, declining technology costs, learning across municipalities, broadband expansion, and the regulatory mandate of the Access to Information Law itself. We therefore read platform substitution as the most plausible interpretation consistent with the service-type pattern, not as an established causal mechanism.

This finding extends the TCT argument beyond the choice among internal, outsourced, and hybrid arrangements. Digital platforms alter the transaction-cost environment in which those choices operate. When a higher-level government provides standardized infrastructure for activities that municipalities would otherwise need to organize locally, part of the value associated with local IT capacity is effectively externalized to a shared infrastructure. The relevant organizational boundary therefore shifts: municipalities need not reproduce locally capa-

bilities that can be reliably standardized and supplied through common platforms. This logic is consistent with recent work conceptualizing digital public infrastructure as shared foundational capabilities for public-interest value creation (Bauer et al., 2025) and with comparative evidence on the multilevel governance of local digital transformation (Kuhlmann et al., 2026).

Yet platform substitution has limits. Transactional services remain tied to local administrative processes, interoperability requirements, citizen data management, procurement routines, and organizational coordination. These activities retain forms of asset specificity that centralized infrastructure cannot easily eliminate. The resulting pattern is therefore one of selective rather than universal equalization: higher-level platforms can raise the digital floor while leaving local organizational capacity consequential for services that resist standardization. This helps reconcile two developments that might otherwise appear contradictory: the increasing centralization of digital infrastructure and the continuing importance of local organizational capacity.

The broader implication is that digital state capacity should not be understood solely as a stock of resources located within individual governments. In increasingly platformized public sectors, some capabilities can be supplied as shared infrastructure across jurisdictional boundaries, while others remain embedded in local organizations. For federal systems in particular, the key governance question may therefore be not simply how much digital capacity municipalities possess, but which capabilities must remain local and which can be effectively provided through higher-level platforms. This channel complements the fiscal and regulatory instruments traditionally emphasized in studies of Brazilian federalism (Arretche, 2012): by supplying shared platforms, the central government can alter the production function of local government without transferring resources or imposing rules—an expression of what Mann (1984) termed infrastructural power.

Organizational and Relational Conditions of Hybrid Governance

Governance structure alone, however, cannot explain how IT teams function. Two municipalities classified as having mixed arrangements may combine public employees and external providers in formally similar ways while differing substantially in the quality of their internal relationships, managerial practices, contractual arrangements, and organizational environments. The effectiveness of hybrid governance may therefore depend on organizational and relational conditions that are not captured by the formal sourcing categories used in this study. Recent research on local digital leadership and broader evidence on digital-service implementation likewise emphasize that organizational and institutional conditions shape digital transformation outcomes (Branderhorst & Ruijer, 2025; Figueredo & Silva, 2026).

Trust is one such condition. Repeated interaction between public employees and external providers can generate shared expectations, communication protocols, and confidence in partners' reliability, potentially reducing monitoring and coordination costs (Schomaker & Bauer, 2022). Conversely, low trust may increase contractual safeguards, monitoring demands, and conflict, reducing the benefits expected from combining internal and external capabilities. Prior organizational history therefore matters: hybrid governance is not created anew in each period but operates through relationships shaped by earlier decisions, interactions, successes, failures, and personnel continuity.

Organizational culture and employee motivation may operate similarly. A collaborative culture may facilitate knowledge exchange across organizational boundaries, whereas cultures characterized by strong public-private segmentation may inhibit the transfer of expertise even when internal and external personnel formally coexist. Motivation may affect whether public employees actively develop the capacity to supervise, learn from, and integrate external expertise rather than becoming passive contract managers. Legal and institutional structures can further condition these relationships by determining procurement flexibility, contractual duration, accountability requirements, personnel stability, and the discretion available to managers. These factors are particularly relevant in public organizations, where sourcing decisions are embedded in legal and political constraints that differ from those faced by private firms (Cordella & Willcocks, 2012). This broader perspective is also consistent with the Economic Commission for Latin America and the Caribbean's (ECLAC, 2025) recent digital-government governance framework for Latin America and the Caribbean, which emphasizes institutional, cultural, organizational, leadership, and technical elements alongside information and communication technology itself.

These considerations qualify how the observed mixed advantage should be interpreted. The results identify an association between governance architecture and service capacity; they do not imply that combining internal and external personnel mechanically produces superior outcomes. Hybrid arrangements create an organizational opportunity for complementarity, but realizing that complementarity may depend on trust, motivation, organizational culture, contractual quality, leadership, and effective integration between internal and external actors. Because MUNIC does not measure these mechanisms, the present study cannot determine which of them explains variation among municipalities with formally similar arrangements. This distinction between governance architecture and organizational functioning represents an important agenda for subsequent research.

Organizational Continuity, Institutional Memory, and the Maturity Gradient

The five-year maturity threshold adds a temporal dimension to this distinction between governance architecture and organizational functioning. Municipalities maintaining IT teams for five or more years exhibit an additional association with formal digital service capacity (β = 0.190, $p < .001$), whereas the linear duration gradient is not significant. Rather than indicating a simple year-by-year accumulation of capacity, the pattern suggests that organizational continuity may matter after a period in which knowledge, routines, and relationships have had time to consolidate.

Institutional memory theory offers one plausible interpretation. Stable IT arrangements may allow context-specific knowledge to move beyond individual employees and become embedded in routines, procedures, communication practices, and organizational relationships. In mixed arrangements, continuity may also strengthen absorptive capacity by allowing internal personnel to develop the knowledge required to evaluate, assimilate, and productively apply expertise obtained from external providers. From this perspective, the history of the governance arrangement becomes potentially as important as its formal structure.

The maturity finding also provides a possible bridge to the relational mechanisms discussed above. Trust, shared routines, and reliable patterns of cooperation are inherently temporal: they develop through repeated interaction rather than through the formal creation of an IT unit. Frequent turnover among employees, contractors, or political leadership may interrupt these processes even when the formal governance category remains unchanged. Conversely, continuity may permit relationships and routines to stabilize. This interpretation is consistent with institutional memory and relational specificity, but the present data cannot establish that either mechanism produced the observed threshold.

Alternative explanations remain plausible. Municipalities capable of maintaining IT teams for five or more years may simply be better governed; more capable administrators may sort into municipalities with mature teams; or capital investment may follow a similar temporal trajectory. The threshold should therefore be treated as a theoretically suggestive pattern rather than evidence that five years constitute a causal maturation period. Because the maturity model includes municipality fixed effects, stable differences in capacity are absorbed, but municipalities on improving trajectories may be those that sustain their teams; the threshold may therefore capture organizational stability or preexisting capacity as much as continuity itself. Direct testing would require data on personnel tenure, turnover, team composition, routine formalization, contractual relationships, trust, and knowledge-sharing practices.

Limitations and Future Research

The findings should be interpreted within four main limitations. First, the study identifies persistent associations rather than causal effects of IT governance arrangements. Significant pre-adoption trends in the event-study analyses indicate positive selection into IT-team adoption, preventing a causal interpretation of the estimated relationships. The duration of IT teams may itself be endogenous to municipal capacity. Future studies exploiting exogenous variation, including electoral discontinuities, regional IT labor-market shocks, or federal programs with differential municipal exposure, could provide stronger identification.

Second, the governance categories capture organizational structure but not organizational functioning. MUNIC does not measure motivation, organizational culture, interpersonal trust, leadership, team integration, contractual quality, knowledge-sharing practices, or the prior history of public-private relationships. These unobserved characteristics may explain why municipalities with formally similar governance arrangements achieve different levels of digital service capacity. Mixed-method and organizational-level studies are particularly important for identifying these mechanisms.

Third, our measures capture the formal availability of relatively basic digital services rather than service quality, usage, citizen experience, or advanced digital integration. A municipality may formally provide a transactional service while citizens experience substantial difficulties using it. Future research should therefore connect governance arrangements not only to formal service supply but also to service quality, take-up, accessibility, and distributional outcomes.

Fourth, the platform equalization interpretation is grounded in the temporal correspondence between the expansion of federal digital infrastructure and convergence in municipal informational services; the present design does not isolate the causal effect of individual federal platforms. Moreover, the Access to Information Law is a regulatory mandate rather than a platform, so regulatory and infrastructural channels cannot be fully separated, and other processes may also contribute to convergence. The 2019 change in the MUNIC definition of an IT team further qualifies comparisons across the 2014–2019 break. Comparative research across federal and multilevel systems could test whether similar patterns emerge where higher-level governments expand shared digital infrastructure. Such comparisons would help establish whether platform substitutability represents a more general boundary condition on the organizational determinants of local digital capacity.

Conclusion

This study asked under what task and infrastructural conditions local IT governance remains consequential for municipal digital service capacity, using 20 years of data covering all 5,569 Brazilian municipalities. The findings provide evidence consistent with transaction cost theory but also qualify a simple expectation that hybrid arrangements uniformly outperform alternative governance forms. Mixed IT arrangements show their strongest association with transactional services, where digital provision remains more dependent on localized administrative knowledge, process integration, and coordination.

The results further indicate that the relevance of local IT governance is contingent on the broader digital infrastructure environment. Between 2012 and 2024, the digital service gap between municipalities with and without dedicated IT teams narrowed substantially, particularly for informational services, alongside the expansion of federal digital platforms. This pattern is consistent with the possibility that higher-level digital infrastructure substitutes for some forms of local organizational capacity while leaving local governance arrangements consequential for services that resist standardization.

A third finding concerns organizational continuity. The five-year maturity pattern is compatible with the possibility that knowledge, routines, and relational capabilities accumulate over time, although the study does not directly observe these mechanisms. More broadly, formal governance architecture should not be equated with organizational functioning: trust, leadership, motivation, organizational culture, contractual quality, and prior relational history may all shape whether the potential complementarity of mixed arrangements is realized.

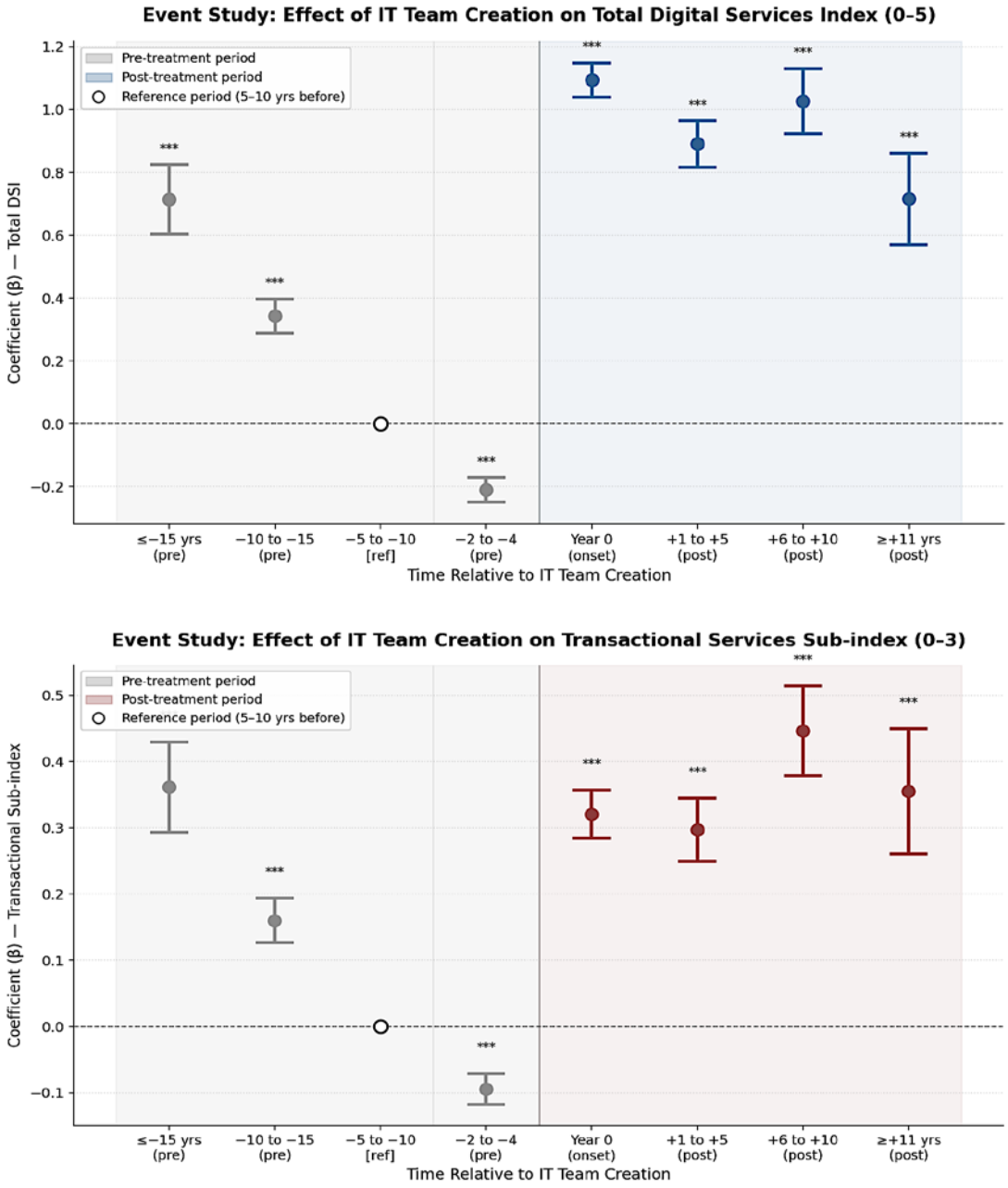
Taken together, these findings answer the question that motivated the study. Local IT capacity remains consequential where tasks are embedded in local administrative processes, where shared infrastructure cannot standardize the capability, and where organizations have been stable long enough to integrate internal and external expertise.

For public management, the implication is not that municipalities should universally adopt hybrid IT structures. Rather, sourcing decisions should reflect the characteristics of the services being governed and the capabilities already available through shared higher-level infrastructure. Internal organizational knowledge appears especially relevant where services require local integration, while standardized capabilities may increasingly be supplied through common platforms. For federal systems, this shifts the digital-governance question from how much capacity should reside locally to which capabilities must remain local and which can be effectively shared across levels of government.

Appendix

Figure A1

Event Study



Note. Top: Total DSI (0–5). Bottom: Transactional Sub-index (0–3). TWFE with municipality and wave FE; controls: log(population), civil servants per 1,000; clustered SEs. Reference: 5–10 years before adoption (open circle). Significant positive pre-trends document positive selection; post-adoption patterns are descriptive longitudinal associations, not causal estimates.

Table A1

Hausman Test and VIF Diagnostics

Panel A. Hausman Test: Fixed Effects, *R*andom Effects, and Between-Effects Estimates

Variable	β (Fixed Effects)	β (Random Effects)	β (Between-Effects)	Δ (FE−RE)
Internal Only	0.112	0.195**	0.220***	−0.083
Outsourced Only	0.146***	0.148***	0.146***	−0.002
Mixed	0.159**	0.326***	0.406***	−0.168
Data Center	0.050	0.175***	0.228***	−0.126
In-House Software Dev.	0.165***	0.181***	0.190***	−0.017
Partnership Breadth	0.173***	0.175***	0.164***	−0.002
Log (Population)	−0.577	0.056	0.041**	−0.633
Civil Servants/1,000	−0.005***	−0.005***	−0.004	0.000
R^2	0.048 (within)	0.133 (overall)	0.188	

Note. Hausman $\chi^2(10) = 40.909$, **p < .01, ***p < .001.

Panel B. VIF Diagnostics for the Primary M3 Model

Variable	VIF
Internal Only	1.23
Outsourced Only	1.44
Mixed	2.17
Data Center	1.77
In-House Software Dev.	1.25
Partnership Breadth	2.69
Federal Partnership	2.21
Private Partnership	1.26
Log (Population)	1.87
Log (GDP per capita)	1.36
Civil Servants/1,000	1.25
Maximum	2.69 (all < 5)

Table A2

IPW-Weighted OLS

Variable	β	SE	p
Internal Only	0.228***	0.041	< .001
Outsourced Only	0.146**	0.054	.007
Mixed	0.363**	0.140	.008
Data Center	0.231***	0.042	< .001
In-House Software Dev.	0.188***	0.046	< .001
Partnership Breadth	0.161***	0.029	< .001
Log (Population)	0.098***	0.022	< .001
Log (GDP per capita)	0.261***	0.031	< .001

Note. Before reweighting: max SMD = 1.44; after: all SMDs < 0.05.
N = *5,569.* *p < *.05,* **p < *.01,* ***p < *.001.*

Table A3

Mundlak–Poisson

Between-Effects and Mundlak–Poisson IRRs

Variable	Total: BE	Total: Mundlak	Trans.: BE	Trans.: Mundlak
Internal Only	1.065***	1.032	1.057**	1.032
Outsourced Only	1.045***	1.046**	1.039**	1.054**
Mixed	1.111***	1.042*	1.120***	1.056**
Data Center	1.066***	1.015	1.095***	1.018
In-House Software Dev.	1.049***	1.033**	1.049***	1.030*
Log (Population)	1.018***	1.067***	1.025***	1.058***
Log (GDP per capita)	1.082***	1.072***	1.098***	1.083***
N	11,124	11,124	11,124	11,124

Note. Mundlak adds entity-level means of time-varying regressors. Mixed remains significant; Internal Only attenuates. *p < *.05,* **p < *.01,* ***p < *.001.*

Table A4

Federal Policy Milestones

Milestone	Date	Relationship to findings
Federal E-Government Program	April 2000	Federal digital infrastructure; contextualizes positive pre-trends in event study
Access to Information Law	November 2011	First mandate for digital citizen channels; consistent with pre-adoption dip
e-SIC launch	2012	Standardized LAI platforms; temporally aligned with gap contraction beginning
GOV.BR portal launch	July 2019	Universal federal portal with 4,500+ services; primary temporal correlate of gap contraction from +2.28 to +0.54

Note. Milestones are temporally aligned with the platform equalization pattern; other contemporaneous factors may contribute.

Table A5

Poisson Count Models — Full Specification (Layer 2)

Variable	Total IRR	Info. IRR	Trans. IRR
Internal Only	1.061***	1.067***	1.057***
Outsourced Only	1.047***	1.047***	1.046***
Mixed	1.093***	1.076***	1.106***

Variable	Total IRR	Info. IRR	Trans. IRR
Data Center (CPD)	1.055***	1.029***	1.075***
In-House Software Dev.	1.042***	1.043***	1.040***
Partnership Breadth	1.030***	1.038***	1.023**
Federal Partnership	1.002	1.004	1.000
Private Partnership	1.031*	1.016	1.042**
Wave 2024	1.076***	1.057***	1.091***
Log (Population)	1.017***	1.008*	1.024***
Log (GDP per capita)	1.078***	1.055***	1.095***
N	11,124	11,124	11,124

Note. Poisson GLM with HC3 robust SEs. IRR = incidence rate ratio. The non-significance of Federal Partnership is consistent with H3.
*p < *.05*, **p < *.01*, ***p < *.001*.

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