

Structural Preconditions of Algorithmic Sovereignty: Informational Fragility and the Institutional Architecture of AI Governance

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Abstract: Artificial intelligence (AI) governance scholarship has largely emphasized regulatory design, ethical safeguards, and algorithmic accountability while presuming consolidated demographic infrastructures. This article argues that algorithmic sovereignty is structurally conditional upon informational coherence and institutional consolidation. It introduces informational fragility as a structural constraint defined as the systemic incapacity of a state to generate unified, reliable, and interoperable demographic intelligence. Using a Design Science Research approach, the study develops the Sovereign Algorithmic Population Governance (GPAS) framework as an institutional architecture composed of three interdependent pillars: Structural Integrity, Institutionalized Algorithmic Capacity, and Governed Interoperability. These pillars articulate the structural preconditions under which algorithmic sovereignty can emerge as a legitimate property of public authority. The framework is operationalized through the Algorithmic Sovereignty Index (ISA), a theory-driven composite indicator derived from the GPAS architecture. An exploratory cross-national calibration demonstrates operational translatability and reveals systematic differentiation between consolidated and information-fragile governance contexts. A prototype-based institutional simulation illustrates architectural plausibility under defined governance constraints. The findings reposition AI governance as an institutional feasibility problem and conceptualize informational consolidation as a foundational dimension of algorithmic-era state capacity.

Keywords: AI Governance; Algorithmic Sovereignty; Informational Fragility; Digital Government; State Capacity; Data Governance; Interoperability Governance; Institutional Design; Digital Sovereignty; Design Science Research.

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I. INTRODUCTION

Artificial intelligence (AI) has become a central component of contemporary public administration, reshaping taxation, social protection targeting, civil registration, border control, and service delivery. As predictive analytics and automated decision systems are integrated into core administrative functions, AI governance has emerged as a defining dimension of digital-era state capacity.

Much of the existing literature, however, implicitly assumes the presence of consolidated demographic infrastructures capable of sustaining algorithmic governance. Digital government research frequently presupposes stable civil registries, interoperable administrative databases, and coherent data architectures. Algorithmic governance is therefore often theorized within institutionally mature digital environments.

This assumption obscures a critical structural reality. In many states, demographic infrastructures remain fragmented, characterized by incomplete civil registration systems,

parallel identity architectures, siloed databases, and weak interoperability frameworks. In such contexts, algorithmic deployment does not necessarily enhance state capacity. Instead, it may reproduce institutional fragmentation, intensify informational incoherence, and amplify dependency on external technological infrastructures.

This article conceptualizes this condition as informational fragility, defined as the systemic inability of a state to generate unified, reliable, and interoperable demographic intelligence capable of sustaining algorithmic governance. Informational fragility constitutes a structural constraint rather than a temporary administrative deficiency. A government may possess fiscal resources and coercive authority while remaining informationally fragile if its population data infrastructures are fragmented or normatively uncoordinated.

➤ *The Central Research Question Guiding this Study is:*

- *Under what Structural and Institutional Conditions can Algorithmic Sovereignty Emerge in States Characterized by Fragmented Demographic Infrastructures?*

To address this question, the article develops a political-institutional framework grounded in a Design Science Research approach. It advances the Sovereign Algorithmic Population Governance (GPAS) framework as an institutional architecture composed of three interdependent pillars: Structural Integrity, Institutionalized Algorithmic Capacity, and Governed Interoperability. These pillars specify the structural preconditions required for algorithmic sovereignty to emerge as a legitimate property of public authority.

The framework is operationalized through the Algorithmic Sovereignty Index (ISA), a multidimensional indicator derived directly from the GPAS architecture. By combining conceptual derivation, exploratory cross-national calibration, and prototype-based institutional simulation, the study bridges theoretical reframing and architectural implementability.

This article makes three contributions. First, it introduces informational fragility as a distinct structural dimension of digital state capacity. Second, it reframes algorithmic sovereignty as an institutional architecture problem rather than a technological autonomy claim. Third, it repositions AI governance as structurally conditional upon informational consolidation and normatively governed interoperability.

By shifting analytical attention from algorithm regulation to institutional feasibility, the article advances a structural theory of AI governance and extends state capacity debates into the algorithmic era.

II. THEORETICAL BACKGROUND

➤ *Digital State Capacity and Informational Infrastructures*

Digital-era governance scholarship has increasingly emphasized the centrality of data integration, platform coordination, and analytics-driven decision-making in shaping state capacity (Dunleavy & Margetts, 2013; Bannister & Connolly, 2014; OECD, 2023; World Bank, 2023). Contemporary assessments such as the World Bank GovTech Maturity Index highlight substantial variation in digital government institutionalization across countries, yet they often focus on service delivery outcomes rather than the structural integrity of underlying demographic infrastructures.

Recent contributions in digital government research further underline that digital transformation in the public sector is fundamentally shaped by institutional design, organizational coordination, and governance structures rather than technological diffusion alone (Cordella & Paletti, 2019; Margetts & Dunleavy, 2013; Zuiderwijk et al., 2021). These perspectives emphasize that performance in digital government depends on architectural coherence, cross-

organizational integration, and normative alignment across administrative layers.

However, this literature largely presupposes the existence of consolidated demographic infrastructures capable of sustaining algorithmic governance. Stable civil registries, interoperable administrative databases, and coherent identity systems are often treated as background conditions rather than analytical variables. This assumption obscures a structural divide between consolidated digital states and information-fragile governance contexts.

From a political perspective, digital state capacity is not merely a function of technological adoption but is embedded in institutional power structures. The production, control, and integration of data reflect broader dynamics of authority, resource distribution, and governance within the state. Informational infrastructures therefore constitute a foundational layer of state power, shaping not only administrative performance but also institutional hierarchies and political influence.

This study extends digital state capacity theory by introducing informational coherence as a structural condition underpinning the feasibility of algorithmic governance.

➤ *Algorithmic Governance as Institutional and Political Process*

Algorithmic governance refers to the integration of predictive analytics, machine learning models, and automated decision-making systems into public administration (Janssen & Kuk, 2016; Wirtz et al., 2023). Existing scholarship has primarily focused on regulatory frameworks addressing transparency, fairness, accountability, and ethical AI deployment (Sun & Medaglia, 2023).

While these contributions are normatively significant, they often assume the availability of reliable and integrated data infrastructures. As Janssen and Kuk demonstrate, the effectiveness of algorithmic systems is inherently constrained by data quality and institutional context. Predictive capacity cannot exceed infrastructural integrity.

Beyond its technical dimension, algorithmic governance is fundamentally an institutional and political process. The deployment of algorithmic systems reshapes decision-making structures, redistributes authority across administrative actors, and transforms governance practices. As Meijer and others have argued, algorithmic systems are embedded within socio-technical arrangements that reflect existing institutional configurations and power relations.

In contexts characterized by informational fragility, algorithmic governance does not simply fail due to technical limitations; it becomes structurally constrained by fragmented infrastructures and competing institutional interests. Consequently, algorithmic governance must be analyzed not only in terms of technological capability but also in relation to institutional feasibility and political dynamics.

➤ *Digital Sovereignty as Institutional and Political Architecture*

Digital sovereignty is frequently framed in geopolitical or technological terms, focusing on data localization, cloud infrastructures, and control over digital platforms. However, this perspective risks overlooking the institutional foundations required to sustain sovereign digital systems.

Building on institutionalist approaches in digital government research (Bannister; Cordella), this article conceptualizes digital sovereignty as an institutional and political architecture. Rather than a function of technological autonomy alone, sovereignty emerges from the capacity of the state to consolidate, govern, and mobilize data within a coherent institutional framework.

From this perspective, algorithmic sovereignty is defined as:

The institutional and political capacity of the state to consolidate, integrate, and govern demographic data within a normatively regulated and analytically operational system.

This conceptualization emphasizes that sovereignty is not inherent to technology but is produced through institutional arrangements and governance structures. It also highlights the political dimension of data governance, where control over information becomes a source of authority and strategic power.

➤ *Research Gap: Toward an Integrated Political-Institutional Framework*

Despite significant advances in digital government and AI governance scholarship, three key dimensions remain analytically fragmented:

- Demographic data infrastructure consolidation
- Algorithmic decision-making capacity
- Interoperability governance frameworks

Existing studies rarely theorize the interaction between these dimensions in contexts characterized by structural fragmentation. Moreover, the political implications of data integration and algorithmic governance particularly in terms of power redistribution and institutional resistance remain insufficiently explored.

This article addresses this gap by developing an integrated framework that links infrastructural conditions, institutional capacity, and political dynamics. By doing so, it moves beyond techno-centric and purely regulatory approaches to AI governance and situates algorithmic sovereignty within the broader context of state transformation.

III. CONCEPTUAL DEVELOPMENT

➤ *Defining Informational Fragility*

This article conceptualizes informational fragility as a systemic incapacity to generate unified, reliable, and

interoperable demographic intelligence necessary for algorithmic governance.

Informational fragility refers to a structural condition in which:

- ✓ Demographic registries are incomplete, inconsistent, or discontinuous;
- ✓ Administrative databases operate in institutional silos;
- ✓ Interoperability mechanisms are weak or normatively uncoordinated;
- ✓ Institutionalized algorithmic capacity remains embryonic or fragmented.

Unlike classical fragile state theory, which emphasizes coercive weakness, fiscal extraction deficits, or political instability, informational fragility highlights the epistemic and infrastructural limits of state authority. A state that cannot reliably account for its population faces structural constraints in governing algorithmically.

To avoid conceptual ambiguity, informational fragility must be distinguished from adjacent notions such as administrative weakness, digital divide, or general state fragility. Administrative weakness refers to deficits in bureaucratic efficiency or policy implementation capacity. The digital divide concerns unequal access to technological infrastructure across social groups. Classical fragile state theory focuses primarily on coercive, fiscal, or political instability.

Informational fragility, by contrast, denotes a structurally specific condition: the systemic inability to generate coherent demographic intelligence across institutional domains. A state may possess fiscal capacity and coercive authority while remaining informationally fragile if its population data infrastructures are fragmented, duplicated, or governed by inconsistent interoperability standards.

Thus, informational fragility is not reducible to political instability or economic underdevelopment. It constitutes an infrastructural and epistemic constraint on algorithmic governance and represents a distinct dimension of digital state capacity.

The concept is advanced as a mid-range analytical construct designed to clarify structural preconditions of algorithmic sovereignty rather than to propose a universal theory of state transformation.

If informational fragility defines the structural limits of demographic coherence, algorithmic sovereignty becomes the positive institutional condition capable of overcoming those limits. The relationship between the two concepts is therefore constitutive: informational fragility identifies the constraint; algorithmic sovereignty specifies the institutional configuration required to transcend it.

➤ *Algorithmic Sovereignty*

Algorithmic sovereignty refers to the institutional capacity of a state to govern through algorithmic systems in a

manner that is coherent, authoritative, and normatively embedded within its constitutional order. It extends classical notions of sovereignty into the digital era by linking informational infrastructure to political authority.

Unlike digital sovereignty narratives that focus primarily on technological autonomy or data localization, algorithmic sovereignty emphasizes institutional coherence. It concerns not merely control over digital infrastructure, but the structured integration of demographic intelligence, interoperability governance, and institutionalized analytics within a legally accountable framework.

Algorithmic sovereignty therefore rests on three interdependent foundations: the structural integrity of population registries, the institutionalization of algorithmic capacity within administrative systems, and the governance of interoperability across public institutions. Absent these conditions, algorithmic deployment risks producing fragmented authority rather than sovereign governance.

In this perspective, sovereignty is not generated by algorithms themselves. Rather, algorithms operate within institutional architectures that condition their legitimacy, effectiveness, and political accountability. Algorithmic sovereignty is thus best understood as a property of institutional design rather than technological possession.

➤ *Theoretical Propositions*

From this conceptualization, four propositions emerge:

- ✓ Proposition 1: Algorithmic sovereignty depends on demographic consolidation.
- ✓ Proposition 2: Algorithmic capacity is conditional upon structural data integrity.
- ✓ Proposition 3: Interoperability must be institutionally governed to ensure legitimacy and prevent unaccountable concentration of informational authority.
- ✓ Proposition 4: Algorithmic sovereignty is an emergent property of systemic institutional integration rather than technological adoption.

These propositions constitute the theoretical backbone of the GPAS framework.

Algorithmic sovereignty, as conceptualized in this article, should not be interpreted as a prescriptive model of state dominance. It functions as a heuristic device to examine how institutional integration conditions the feasibility of algorithmic governance under democratic and constitutional constraints.

➤ *Integrative Theoretical Framework: From Informational Fragility to Algorithmic Statehood*

Contemporary research on digital government, algorithmic governance, and digital sovereignty has largely evolved along parallel analytical trajectories, with limited theoretical integration. While digital government literature emphasizes institutional capacity and service delivery, algorithmic governance focuses on regulatory and ethical dimensions, and digital sovereignty debates center on

technological autonomy and geopolitical control. This fragmentation obscures a fundamental structural relationship: the emergence of algorithmic governance is conditioned by the coherence of underlying informational infrastructures.

This article advances an integrative theoretical framework that positions informational fragility as a foundational constraint shaping the feasibility of algorithmic sovereignty. Rather than conceptualizing AI governance as a problem of regulation or technological deployment, the analysis reframes it as a function of institutional alignment across three interdependent layers.

First, the informational infrastructure layer captures the structural integrity of demographic systems. It determines whether the state is capable of producing unified, reliable, and continuous population intelligence. In contexts where civil registries are fragmented, incomplete, or institutionally disconnected, algorithmic systems lack a coherent epistemic foundation. Informational fragility at this level therefore constitutes a structural limit to algorithmic governance.

Second, the institutional-analytical layer reflects the degree to which algorithmic systems are embedded within administrative processes. This layer encompasses not only technical capacity but also organizational integration, human expertise, and decision-making transformation. Algorithmic capacity, in this sense, is not reducible to technological adoption; it is an institutional property shaped by governance structures and administrative practices.

Third, the governance-normative layer ensures that interoperability is regulated, accountable, and aligned with constitutional principles. While technical interoperability enables data exchange, governed interoperability determines its legitimacy. Legal frameworks, oversight institutions, and accountability mechanisms are therefore constitutive elements of algorithmic governance rather than external regulatory constraints.

These three layers are structurally interdependent and mutually conditioning. Informational fragility at the infrastructural level constrains the development of algorithmic capacity, while weak governance frameworks undermine both integration and legitimacy. Conversely, high levels of structural integrity without institutional embedding may result in administrative archivalism, and interoperability without governance may produce unaccountable concentration of informational authority.

This integrative architecture is summarized in Figure 1.

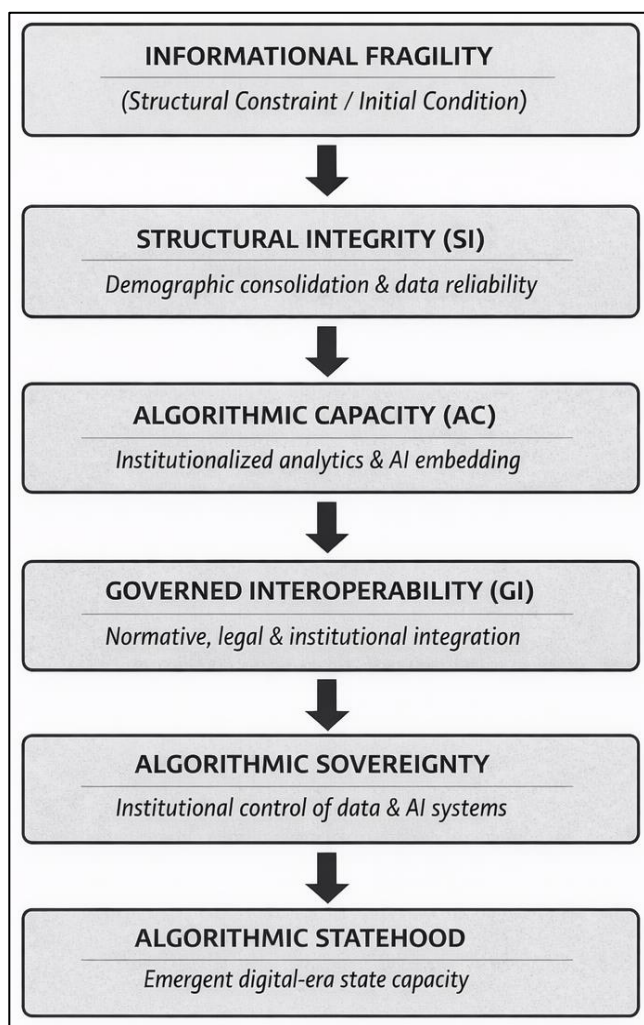


Fig 1 Integrative Architecture of Algorithmic Sovereignty

Within this framework, algorithmic sovereignty is reconceptualized as an emergent institutional property arising from the alignment of these three layers. It is not a function of technological control alone, but of the state's capacity to consolidate demographic information, operationalize it through institutionalized analytics, and govern its circulation within a normatively regulated system.

The GPAS framework operationalizes this theoretical architecture by translating the three layers into measurable institutional pillars:

- ✓ Structural Integrity (SI),
- ✓ Institutionalized Algorithmic Capacity (AC),
- ✓ Governed Interoperability (GI).

This translation ensures coherence between theoretical abstraction and empirical operationalization, linking conceptual architecture (Section 2), institutional design (Section 4), and measurement logic (Section 5).

Building on this integration, the study advances a broader theoretical proposition:

Algorithmic statehood in the digital era is structurally determined by informational coherence, institutionally mediated by algorithmic capacity, and normatively bounded by governance architectures.

This proposition extends classical state capacity theory by introducing informational capacity as a foundational dimension of statehood, alongside fiscal, administrative, and coercive capacities. In doing so, it contributes to a structural theory of AI governance in which the feasibility of algorithmic systems is conditioned not by technological availability, but by institutional configuration.

IV. RESEARCH DESIGN

➤ Methodological Positioning

This study adopts a Design Science Research (DSR) approach to develop a theoretically grounded governance framework addressing informational fragility in digital government contexts.

DSR is appropriate when the research objective is not only to explain phenomena but to construct and theorize institutional artefacts that address structurally defined problems (Hevner et al., 2004). In digital government research, DSR has increasingly been used to develop governance models, interoperability frameworks, and institutional architectures rather than purely technical systems.

In this article, the artefact under development—the Sovereign Algorithmic Population Governance (GPAS) framework—is conceptualized not as a technological system, but as an institutional architecture responding to a theoretically defined problem: structural informational fragility.

The choice of DSR is therefore epistemologically justified by the need to:

- Translate theoretical gaps into institutional design principles,
- Formalize interdependencies between state capacity dimensions,
- Operationalize a governance framework in a measurable form.

This study adopts a theory-driven design science approach situated within analytical institutionalism rather than engineering implementation research. The artefact is conceptual-architectural, and its validity is assessed through logical coherence, theoretical triangulation, and operational plausibility rather than experimental performance testing.

➤ Problem Identification

The first stage of the research design consists of conceptual problem identification grounded in literature synthesis.

Through systematic engagement with digital government theory (Dunleavy & Margetts; Bannister;

Janssen; Meijer; Zuiderwijk), algorithmic governance scholarship, and emerging work on digital sovereignty, a structural gap was identified:

Existing frameworks assume consolidated demographic infrastructures and do not sufficiently theorize contexts where such infrastructures are fragmented.

This diagnostic stage establishes informational fragility as a structural constraint on algorithmic governance.

Importantly, the problem is conceptual rather than technological.

The research does not begin with the question “Which technology should be implemented?” but with:

What institutional conditions are necessary for algorithmic sovereignty to emerge in structurally fragile environments?

The design science process adopted in this study is summarized in *Figure 1*. The figure illustrates the sequential yet analytically structured progression from problem diagnosis to architectural formalization and coherence evaluation.

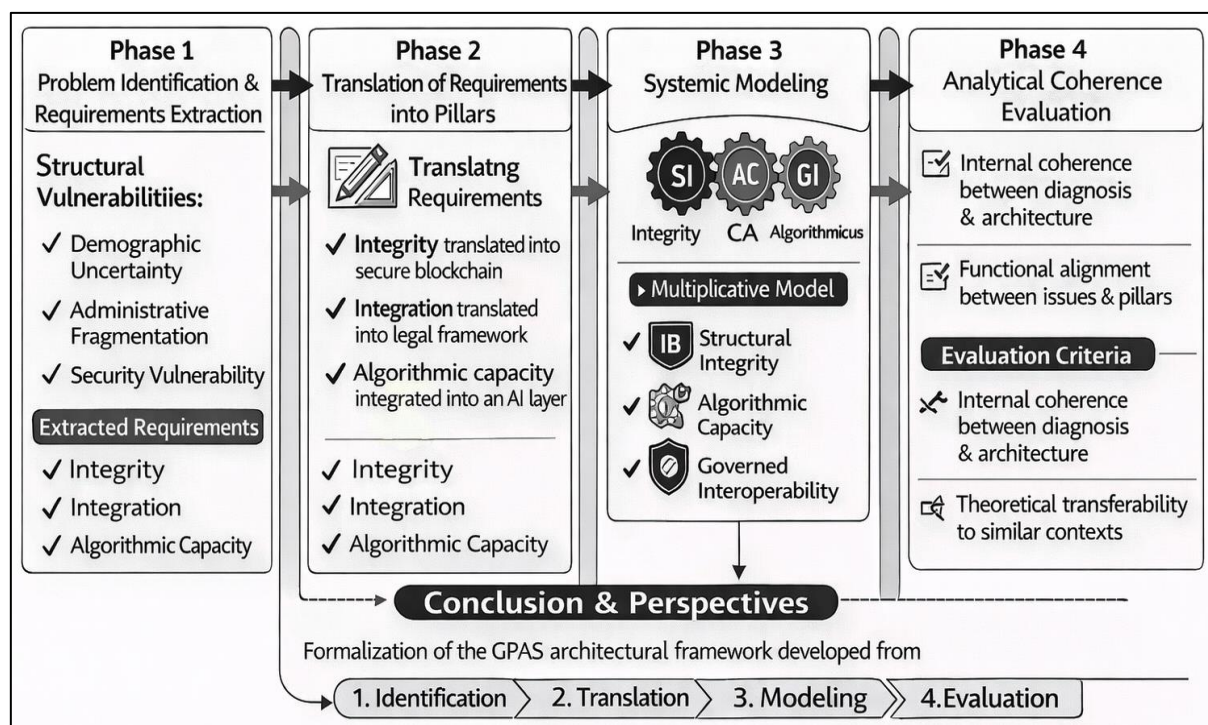


Fig 2 Design Science Research Process Underlying the GPAS Framework.
Source: Author's conceptual elaboration within the GPAS analytical framework.

The figure illustrates the structured progression from problem identification to architectural modeling and analytical evaluation within the design science approach.

➤ *Artefact Development: Institutional Architecture*
The second stage involves artefact construction.

The GPAS framework is developed as a governance architecture integrating three interdependent institutional capacities:

- Structural Integrity (demographic consolidation),
- Algorithmic Capacity (institutional analytics),
- Governed Interoperability (normative integration).

The artefact is theoretical-institutional rather than technical-engineering in nature.

In DSR terms, GPAS constitutes a:

- Governance model,
- Conceptual design,
- Institutional configuration.

Its contribution lies in articulating systemic relationships between dimensions traditionally studied in isolation.

➤ *Operationalization Logic*

A distinctive feature of this Design Science Research approach is the development of an operational index the Algorithmic Sovereignty Index (ISA).

The ISA is not introduced as an empirical measurement instrument detached from theory. Rather, it is structurally derived from the GPAS institutional architecture. Its dimensional structure directly reflects the three interdependent pillars defined earlier.

The use of geometric aggregation is theoretically grounded in three core assumptions:

- Multidimensionality of sovereignty
- Interdependence among institutional pillars
- Non-compensability of structural weaknesses

Geometric aggregation therefore operationalizes the systemic logic of GPAS rather than serving as a purely technical statistical choice.

This operationalization ensures alignment between conceptual architecture and measurement logic an essential criterion for methodological coherence within a design science paradigm.

The operationalization process follows a strict derivational sequence: theoretical pillars (Section 2) → institutional architecture (Section 4) → measurable dimensions (Section 5). This structured progression preserves construct integrity and prevents conceptual drift between theoretical definition and empirical approximation.

➤ *Evaluation Strategy*

Consistent with conceptual traditions of Design Science Research in public administration, evaluation in this study is primarily analytical rather than experimental. The artefact is not subjected to large-N statistical validation or causal hypothesis testing. Instead, its robustness is assessed through structured theoretical triangulation across digital government scholarship, state capacity theory, and algorithmic governance research.

The artefact is evaluated through four complementary mechanisms:

- Internal coherence analysis: Examination of logical consistency between problem diagnosis (informational fragility) and the proposed institutional architecture (GPAS).
- Theoretical alignment assessment: Verification of compatibility with established digital government and state capacity literatures.
- Illustrative institutional application: Diagnostic application to the Democratic Republic of Congo as a theoretically sampled configuration characterized by informational fragility.
- Exploratory empirical calibration: A cross-national operational approximation introduced in Section 5 to assess the measurability and structural coherence of the Algorithmic Sovereignty Index (ISA).

The exploratory calibration does not constitute statistical validation of the artefact. Rather, it serves as a proof of operational translatability, demonstrating that the theoretical architecture can be consistently translated into measurable institutional dimensions using publicly available indicators. The empirical component therefore strengthens operational plausibility without altering the conceptual-architectural nature of the contribution.

Similarly, the DRC case does not function as causal validation or econometric testing. It operates as a plausibility probe, illustrating how the framework structures institutional diagnosis within a real-world configuration of layered informational fragmentation.

Within the design science paradigm, this level of evaluation corresponds to early-stage artefact validation, appropriate for governance architectures seeking to establish analytical coherence and operational viability prior to large-scale empirical testing.

Epistemologically, this study adopts a mid-range theoretical orientation. It does not aim to construct a universal theory of state formation nor to prescribe an ideal model of digital governance. Instead, it advances a structured analytical framework designed to illuminate a specific structural constraint informational fragility and its implications for algorithmic governance.

The contribution is therefore conceptual-architectural rather than causal-explanatory. GPAS does not predict governance outcomes; it clarifies institutional conditions under which algorithmic sovereignty becomes structurally feasible. By introducing informational coherence as a distinct analytical dimension of state capacity, the study extends digital government theory into contexts where infrastructural consolidation cannot be assumed.

The exploratory cross-national calibration is not intended as statistical validation of the artefact. Rather, it assesses the operational translatability of the conceptual architecture into measurable institutional dimensions. Within a design science framework, it constitutes an instantiation-level plausibility demonstration rather than a hypothesis-testing exercise.

➤ *Scope and Limitations*

This research design maintains three deliberate boundaries:

- It does not test causal impact using large-scale quantitative datasets.
- It does not implement technological systems or pilot institutional reforms.
- It does not claim immediate policy effectiveness.

The exploratory empirical calibration presented in Section 5 is illustrative and operational rather than statistically generalizable. Its purpose is to demonstrate dimensional feasibility and internal consistency, not predictive validity.

Accordingly, the study advances a theoretical-institutional model intended to guide subsequent empirical inquiry rather than to provide definitive measurement claims.

Future research should:

- Extend ISA calibration to larger cross-national samples;

- Conduct longitudinal analyses of institutional consolidation trajectories;
- Refine indicator selection and weighting strategies;
- Test causal relationships between informational consolidation and governance outcomes;
- Apply robustness, sensitivity, and alternative aggregation techniques to evaluate dimensional stability.

These extensions would enable empirical deepening while preserving the conceptual-architectural integrity of the GPAS framework.

V. THE GPAS FRAMEWORK: INSTITUTIONAL ARCHITECTURE OF ALGORITHMIC SOVEREIGNTY

➤ *From Theoretical Integration to Institutional Architecture*

Building on the integrative theoretical framework developed in Section 2.4, the GPAS framework translates the three-layered conceptual model informational infrastructure, institutional-analytical embedding, and governance-normative regulation into a structured institutional architecture.

While Section 2.4 conceptualizes algorithmic sovereignty as an emergent property of institutional alignment, the GPAS framework operationalizes this alignment by specifying the institutional conditions under which such alignment becomes feasible.

In this perspective, GPAS is not a technological system, nor a prescriptive reform blueprint. It is an analytical institutional architecture designed to diagnose the degree of coherence between the foundational layers of algorithmic governance.

As illustrated in Figure 0, algorithmic sovereignty emerges from the alignment of three interdependent institutional pillars:

- Structural Integrity (SI),
- Institutionalized Algorithmic Capacity (AC),
- Governed Interoperability (GI).

The GPAS framework thus functions as the institutional translation of the integrative theoretical model, ensuring continuity between conceptual abstraction and governance design.

➤ *Pillar I: Structural Integrity as Informational Foundation*

Structural Integrity corresponds to the informational infrastructure layer defined in Section 2.4. It constitutes the ontological foundation of algorithmic governance by determining whether demographic data can be treated as a reliable epistemic resource.

This pillar encompasses:

- Coherence and continuity of civil registries,
- Elimination of duplicate or conflicting identities,

- Institutional mechanisms for data validation,
- Longitudinal consistency of demographic records.

Structural Integrity is not reducible to centralization. Rather, it reflects systemic coherence across distributed administrative units.

In contexts of informational fragility, weak structural integrity constrains algorithmic systems at their source, limiting predictive reliability and amplifying systemic errors. Algorithmic governance, therefore, cannot exceed the quality of its informational substrate.

Within the GPAS framework, Structural Integrity defines the possibility condition of algorithmic sovereignty.

➤ *Pillar II: Institutionalized Algorithmic Capacity as Analytical Mediation*

Institutionalized Algorithmic Capacity corresponds to the institutional-analytical layer identified in Section 2.4. It captures the extent to which algorithmic systems are embedded within administrative processes and decision-making structures.

This pillar includes:

- Integration of analytics units within ministries,
- Formalization of data modeling and decision-support systems,
- Development of human expertise in AI and data governance,
- Institutional procedures for bias detection and model validation.

Algorithmic capacity is not a function of technological acquisition alone. It is an institutional property, shaped by organizational structures, governance routines, and administrative practices.

Without institutional embedding, algorithmic tools remain peripheral and fail to transform governance processes. Conversely, embedded analytical capacity enables the transformation of demographic data into actionable institutional intelligence.

This pillar thus represents the mediating layer through which informational resources are converted into governance capacity.

➤ *Pillar III: Governed Interoperability as Normative Regulation*

Governed Interoperability corresponds to the governance-normative layer articulated in Section 2.4. It ensures that data integration processes are legally regulated, institutionally accountable, and normatively aligned with constitutional principles.

This pillar encompasses:

- Standardized protocols for data exchange,

- Legal frameworks for data protection and privacy,
- Independent oversight authorities,
- Auditability and transparency mechanisms.

While technical interoperability enables data circulation, governed interoperability defines its legitimacy and political acceptability.

In the absence of normative governance, interoperability risks producing concentration of informational power without accountability. Conversely, excessive regulatory fragmentation may inhibit integration and reduce system efficiency.

Governed Interoperability thus represents the balancing mechanism between efficiency and democratic control within algorithmic governance.

➤ *Systemic Interdependence and Non-Compensatory Logic*

The three pillars of the GPAS framework are structurally interdependent and operate under a non-compensatory logic, consistent with the theoretical model developed in Section 2.4.

- Strong algorithmic capacity cannot compensate for weak structural integrity.
- Interoperability without governance generates institutional imbalance.
- Structural consolidation without analytical embedding produces administrative inertia rather than strategic intelligence.

Algorithmic sovereignty emerges only when the three pillars are simultaneously aligned.

This interdependence justifies the use of geometric aggregation in the ISA operationalization (Section 5), ensuring that weaknesses in one dimension cannot be offset by strengths in others.

➤ *Institutional Sequencing and Layered Alignment*

In contexts characterized by informational fragility, institutional sequencing becomes critical. The GPAS framework implies a structured progression aligned with the three-layered theoretical model:

- Stabilization of informational infrastructure (Structural Integrity),
- Establishment of governance frameworks (Governed Interoperability),
- Gradual embedding of analytical capacity (Algorithmic Capacity).

This sequencing reflects the principle that analytical expansion without informational consolidation leads to systemic incoherence.

As illustrated in Figure 2, cryptographic integrity may function as a cross-cutting reinforcement layer, enhancing trust and resilience without altering the sequencing logic.

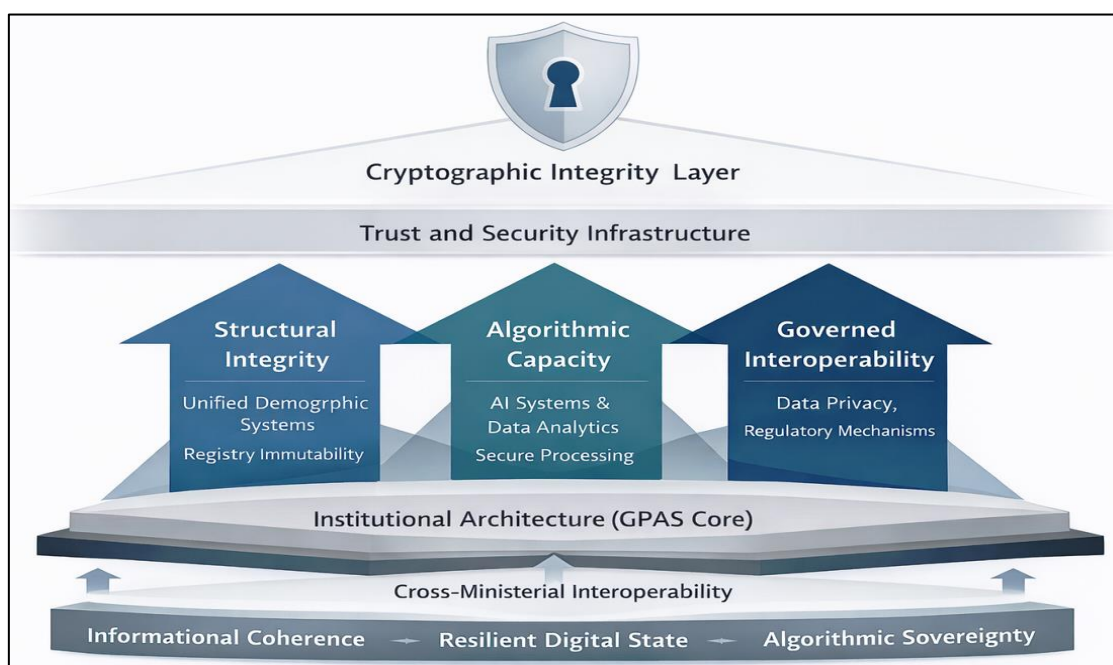


Fig 3 Extended GPAS Architecture with Cryptographic Integrity Layer.

Source: Author's Conceptual Elaboration within the GPAS Analytical Framework.

➤ *GPAS as Institutional Bridge Between Theory and Measurement*

The GPAS framework serves as the central bridge linking:

- The integrative theoretical model (Section 2.4),
- The institutional architecture (Section 4),
- The empirical operationalization through ISA (Section 5).

Each pillar directly corresponds to a measurable dimension:

- Structural Integrity → SI,
- Algorithmic Capacity → AC,
- Governed Interoperability → GI.

This alignment ensures methodological coherence and prevents conceptual drift between theory and empirical approximation.

➤ *Power, Institutional Resistance, and Political Dynamics*

Institutional alignment is not purely technical; it is inherently political.

The consolidation of demographic infrastructures and the introduction of interoperable systems reshape informational asymmetries within the state. Agencies that historically controlled sector-specific data may resist integration to preserve institutional autonomy.

Algorithmic sovereignty therefore emerges through negotiated institutional transformation, involving:

- Redistribution of informational authority,
- Reconfiguration of administrative hierarchies,
- Balancing of efficiency and autonomy.

The GPAS framework explicitly incorporates these political dynamics, recognizing that informational coherence is both a technical and institutional achievement.

➤ *Generalizability and Boundary Conditions*

Although illustrated through information-fragile contexts, the GPAS framework is analytically generalizable to:

- Developing countries undergoing digital transformation,
- Transitional governance systems,
- Advanced digital states seeking institutional integration.

However, GPAS does not claim to:

- Ensure democratic accountability,
- Resolve fiscal or political instability,
- Substitute for broader state capacity dimensions.

It addresses a specific structural domain: informational coherence as a precondition for algorithmic governance.

VI. EMPIRICAL OPERATIONALIZATION AND EXPLORATORY CALIBRATION OF ALGORITHMIC SOVEREIGNTY

➤ *From Institutional Architecture to Measurement Framework*

Building on the institutional architecture developed in Section 4, the Algorithmic Sovereignty Index (ISA) operationalizes the GPAS framework into a structured measurement model.

While Section 2.4 conceptualizes algorithmic sovereignty as an emergent property of institutional alignment, and Section 4 specifies the architecture through three interdependent pillars, the ISA translates these pillars into measurable dimensions.

The objective of the ISA is not to produce a technological ranking, but to capture the degree of institutional coherence underlying algorithmic governance.

Each dimension of the ISA directly corresponds to a pillar of the GPAS framework:

- Structural Integrity → SI
- Institutionalized Algorithmic Capacity → AC
- Governed Interoperability → GI

This direct mapping ensures full theoretical consistency and preserves construct validity across levels of analysis.

➤ *Indicator Selection and Theoretical Justification*

The selection of indicators follows a theory-driven operationalization logic, ensuring alignment with the conceptual architecture rather than empirical convenience.

• *Structural Integrity (SI) — Informational Foundation*

Structural Integrity is operationalized using: *Birth registration completeness (%)*

This indicator captures the foundational reliability of demographic infrastructure, reflecting the state's ability to produce continuous and unified population data.

It aligns with the informational infrastructure layer (Section 2.4) and the Structural Integrity pillar (Section 4.2), representing the epistemic condition of algorithmic governance.

• *Institutionalized Algorithmic Capacity (AC) — Analytical Embedding*

Algorithmic Capacity is proxied by: *Online Service Index (OSI) — UN EGDI*

The OSI reflects the institutional embedding of digital administrative capacity, including integration of services, data usage, and process digitalization.

Although it does not directly measure AI deployment, it captures the institutional readiness for algorithmic integration, consistent with the analytical mediation role described in Section 4.3.

• *Governed Interoperability (GI) — Normative Regulation*

Governed Interoperability is operationalized through a legal-institutional indicator:

- ✓ 0 = No data protection framework
- ✓ 1 = Legal framework adopted
- ✓ 2 = Legal framework + independent authority

This indicator captures the normative governance of data exchange, aligning with the governance layer (Section 2.4) and the interoperability pillar (Section 4.4).

It reflects not only the existence of rules, but the institutionalization of accountability mechanisms.

➤ *Normalization and Cross-Dimensional Comparability*

To ensure analytical consistency, all indicators are normalized to a [0–1] scale.

- Birth registration → /100
- OSI → already normalized
- Interoperability score → /2

This normalization ensures comparability across dimensions while preserving the structural meaning of each indicator.

➤ *Non-Compensatory Aggregation and Systemic Logic*

Consistent with the GPAS framework, the ISA adopts a non-compensatory aggregation logic through geometric mean:

$$ISA = (SI \times AC \times GI)^{(1/3)}$$

Where SI, AC, and GI ∈ [0,1]

This formulation reflects three core theoretical principles:

- Interdependence: The three pillars operate as a system, not as independent variables.
- Non-substitutability: Weakness in one dimension cannot be offset by strength in another.
- Structural coherence requirement: Algorithmic sovereignty emerges only when all pillars are aligned.

Thus, the aggregation method is not statistical convenience, but a direct translation of the architectural logic defined in Section 4.5.

➤ *Exploratory Cross-National Calibration*

To assess operational feasibility, the ISA is applied to a heterogeneous sample of countries representing varying degrees of institutional consolidation.

The sample includes:

- Highly consolidated digital states,
- Transitional institutional systems,
- Information-fragile contexts.

This selection enables structural comparison across different configurations of algorithmic governance.

The results reveal three distinct clusters:

- High ISA (>0.90) → Institutional alignment (e.g., Estonia, South Korea)
- Intermediate ISA (0.50–0.80) → Partial alignment

- Low ISA (<0.50) → Informational fragility

These results confirm that the ISA captures systemic institutional differentiation, rather than technological diffusion alone.

➤ *Structural Interpretation and Theoretical Alignment*

The empirical calibration supports the theoretical propositions developed in Sections 2.4 and 4.

- High ISA values correspond to alignment across all three pillars, reflecting algorithmic sovereignty conditions.
- Intermediate values reveal partial institutional integration, often characterized by asymmetry between pillars.
- Low values indicate structural informational fragility, where at least two dimensions are underdeveloped.

Importantly, the ISA does not replicate existing indices such as EGDI or Government Effectiveness. Instead, it captures a distinct dimension: informational coherence as a structural condition of governance.

➤ *Robustness, Sensitivity, and Dimensional Stability*

Alternative weighting scenarios were tested to evaluate the robustness of the index.

Across simulations:

- Relative country rankings remain stable,
- Extreme values are consistent,
- Structural differentiation persists.

This confirms that ISA results are driven by institutional configuration, not aggregation artifacts.

➤ *Analytical Scope and Methodological Boundaries*

The ISA is an exploratory structural index, not a causal measurement tool.

It does not:

- Establish causal relationships,
- Predict governance outcomes,
- Replace detailed institutional analysis.

Instead, it serves as an analytical instrument translating institutional architecture into measurable form.

➤ *Toward a Measurement Theory of Algorithmic Statehood*

Beyond operationalization, the ISA contributes to a broader theoretical objective: the measurement of algorithmic statehood.

By linking:

- Informational infrastructure,
- Institutional embedding,
- Governance regulation,

The index provides a first approximation of how states transition from informational fragility to algorithmic sovereignty.

This perspective extends measurement frameworks in digital government by introducing informational coherence as a core dimension of state capacity.

VII. ILLUSTRATIVE CASE: THE DEMOCRATIC REPUBLIC OF CONGO

➤ *Rationale and Analytical Positioning*

The Democratic Republic of Congo (DRC) is examined as an illustrative configuration of informational fragility within African digital governance contexts. This section does not propose a reform blueprint, nor does it claim empirical validation of the GPAS framework. Rather, it deepens the institutional analysis that conceptually underpins the exploratory ISA calibration presented in Section 5.

The case is selected through theoretical sampling rather than statistical representativeness. The objective is not generalization through case frequency, but analytical illumination of a structurally layered institutional configuration. In this sense, the DRC serves as a plausibility-oriented case, chosen for its diagnostic relevance to the concept of informational fragility.

Three structural characteristics justify its analytical selection:

- Demographic scale combined with statistical discontinuity, creating systemic challenges for registry consolidation;
- Institutional layering across colonial, post-colonial, and post-conflict administrative trajectories, resulting in sedimented governance arrangements;

- Registry fragmentation patterns comparable to those observed across multiple African governance systems, allowing for comparative typological positioning.

The DRC therefore functions as a theory-building configuration rather than a performance-ranking case. Its analytical purpose is to demonstrate how informational fragility manifests institutionally within a complex administrative environment.

By examining this configuration, the study illustrates how layered fragmentation constrains structural integrity, institutionalized algorithmic capacity, and governed interoperability. The case thus operationalizes informational fragility as a structural condition, reinforcing the internal coherence between conceptual architecture and institutional diagnosis.

➤ *Informational Fragility as Institutional Configuration*

From an informational standpoint, the DRC exhibits structural fragmentation characterized by:

- Absence of a comprehensive national census for several decades;
- Predominantly manual or partially digitized civil registration systems;
- Parallel identity infrastructures administered by distinct institutions;
- Limited standardized interoperability across sectoral databases.

The coexistence of electoral voter registries and civil registration databases illustrates this fragmentation. Electoral databases are periodically reconstructed according to sectoral mandates, yet these systems are not embedded within a unified demographic backbone. Informational fragility thus manifests as functional registry production without enduring institutional consolidation.

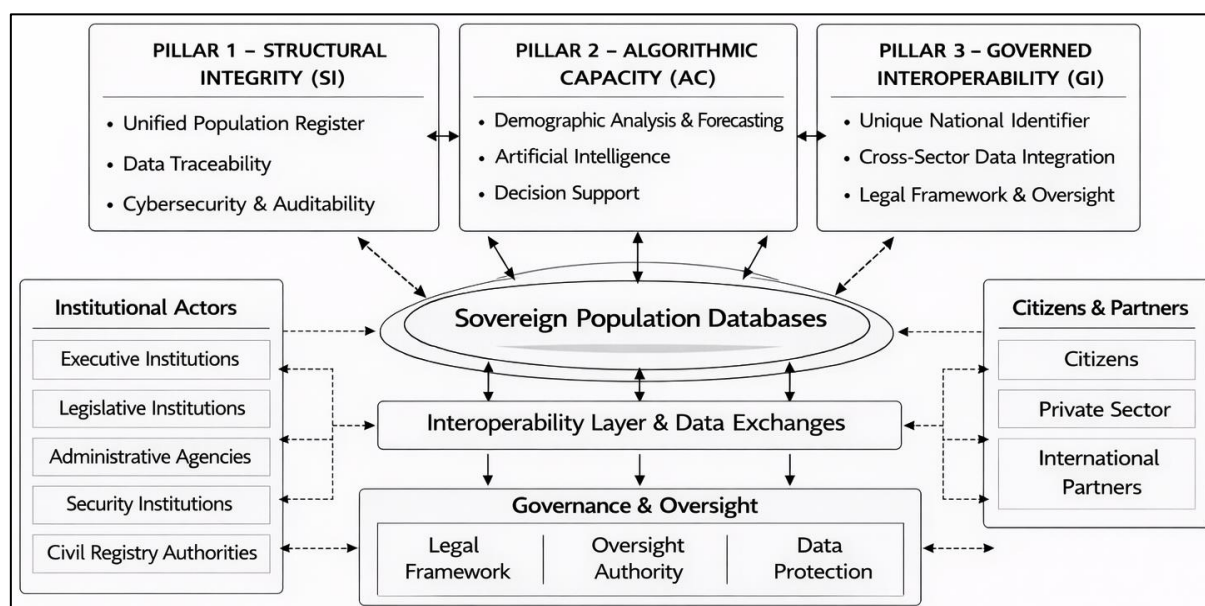


Fig 4 Illustrative Institutional Configuration of Population Data Governance (DRC Context).

Source: Author's Analytical Synthesis.

➤ Dimension-by-Dimension Institutional Diagnosis

• Structural Integrity (SI)

Demographic discontinuity constrains structural integrity. Parallel registry systems lack sustained harmonization, resulting in fragmented population intelligence. This configuration aligns with the low SI score (0.35) reported in Section 5.

• Institutionalized Algorithmic Capacity (AC)

Digital initiatives exist across sectors, yet analytics functions are not systematically embedded within a coherent cross-ministerial governance architecture. Data utilization remains largely transactional rather than predictive or strategically integrated. This corresponds to the moderate but limited AC score (0.45).

• Governed Interoperability (GI)

Governed interoperability remains the most fragile dimension. Cross-validation protocols are partial, regulatory oversight is limited, and harmonized standards across registries are weak. This condition corresponds to the low GI score (0.25).

➤ Comparative African Context

Situating the DRC within broader African digital identity trajectories provides analytical depth. Across the continent, identity reforms have followed heterogeneous paths:

- Rwanda has pursued relatively centralized identity consolidation;
- Kenya's Huduma Namba program has encountered legal contestation;
- Nigeria's NIN system has expanded registry coverage while facing coordination and trust challenges.

These trajectories demonstrate that informational consolidation is not a linear technological process but a politically embedded institutional transformation. Within this comparative landscape, the DRC represents not an anomaly but an intensified configuration of structural fragmentation.

Table 1 presents an analytical overview of selected African informational configurations.

Nigeria appears both in the ISA exploratory calibration (Section 5) and in the present qualitative comparison. However, its inclusion here serves a typological analytical purpose rather than a metric extension of the ISA results.

Table 1 Analytical Overview of Selected African Informational Configurations

Country	Structural Integrity	Governed Interoperability	Institutionalized Algorithmic Capacity	Institutional Configuration Type
Rwanda	High consolidation of national ID backbone	Centralized governance structure	Emerging institutional embedding	Consolidated digital-centralized model
Kenya	Partial consolidation with legal contestation	Legally contested harmonization	Moderate sectoral embedding	Politically contested integration model
Nigeria	Expanding registry coverage	Fragmented coordination across agencies	Limited systemic embedding	Expansion-fragmented hybrid model
DRC	Low consolidation and demographic discontinuity	Weak harmonization frameworks	Embryonic institutional embedding	Layered informational-fragile configuration

- Note: This table provides a qualitative analytical typology and does not replicate ISA numerical values. Numerical calibration remains limited to countries included in Section 5.

➤ Informational Fragility and Fragile State Theory

Classical fragile state theory has traditionally emphasized coercive capacity, fiscal extraction, and administrative legitimacy (Rotberg, 2004; Migdal, 2001; Fukuyama, 2013). Informational capacity, however, has rarely been treated as an autonomous analytical dimension.

The DRC case suggests that informational fragility operates as a cross-cutting constraint on these classical dimensions. Without demographic consolidation, fiscal planning becomes uncertain; without interoperable registries, security coordination remains partial; without reliable civil registration, political legitimacy may be contested.

Informational coherence therefore intersects with, but does not replace, traditional fragility dimensions. Algorithmic

sovereignty addresses informational capacity rather than total state consolidation.

➤ Institutional Layering and Path Dependency

The present configuration reflects incremental institutional layering. Electoral cycles, migration tracking, education records, and civil registry documentation evolved independently in response to sector-specific mandates. In the absence of harmonized standards, these layers accumulated without systemic consolidation.

Informational fragility is thus structurally embedded through administrative sedimentation rather than abrupt institutional breakdown.

➤ External Dependency and Sovereignty Constraints

Digital identity systems across Africa frequently rely on external system integrators, proprietary biometric technologies, and foreign cloud infrastructures. Such dependency complicates digital sovereignty and raises concerns of vendor lock-in and infrastructural reliance.

Algorithmic sovereignty therefore requires institutional control over governance architectures, regulatory stabilization, and domestic embedding of analytical expertise. Informational consolidation without governance autonomy does not constitute sovereignty.

➤ *Prototype-Based Institutional Simulation*

To illustrate the operational implications of the GPAS framework, a functional prototype was developed as a simulation of cross-institutional access architecture within an information-fragile environment.

Figure 4 presents a simplified representation of the institutional access simulation interface.

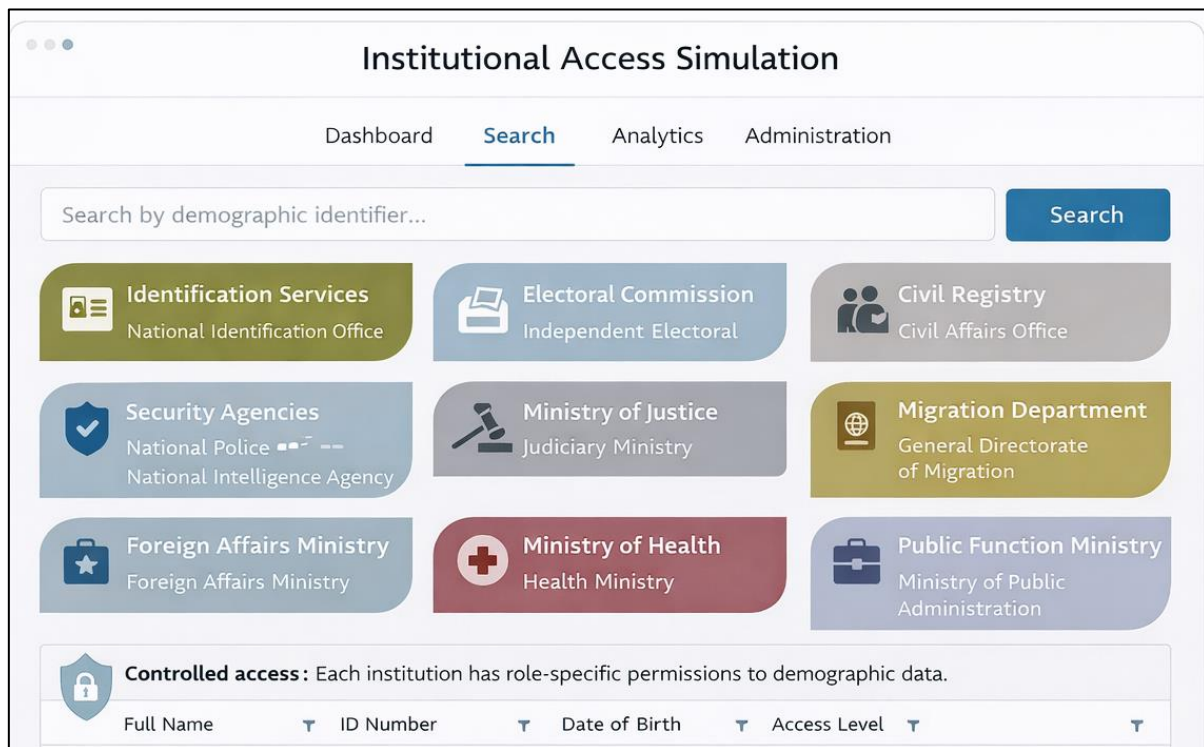


Fig 5 Institutional Access Simulation Prototype (Analytical Illustration).

Source: Author's Applied Demonstration within the GPAS Framework.

The prototype does not represent a deployed national infrastructure. Rather, it serves as a structured demonstration of how institutional interoperability could be operationalized under a unified demographic registry model. Its purpose is analytical and illustrative: to translate the architectural logic of GPAS into a simulated interface environment.

The prototype interface presents authorized institutional actors with differentiated access privileges. These include national identification authorities, civil registry services, electoral institutions, migration services, justice bodies, security agencies, and selected ministerial departments. Access is role-based, meaning that institutions do not possess unrestricted visibility across all data layers. Permissions are structured according to legally defined functional mandates.

This simulated architecture operationalizes the three theoretical pillars of GPAS:

- Structural Integrity — through centralized demographic consolidation;
- Institutionalized Algorithmic Capacity — via structured search and analytical modules;

- Governed Interoperability — through controlled cross-ministerial access permissions.

Importantly, the prototype demonstrates that interoperability does not require institutional fusion. Each institution retains administrative autonomy while accessing harmonized demographic identifiers through a secured interface layer. This reflects the principle that informational coherence can coexist with bureaucratic pluralism.

The simulation further highlights a critical distinction: technological integration alone does not resolve informational fragility. Without demographic stabilization and governance standards, shared access risks amplifying fragmentation rather than resolving it.

Thus, the prototype functions as an architectural plausibility demonstration of the GPAS sequencing logic. It illustrates how institutional consolidation precedes analytical expansion, and how cryptographic integrity mechanisms can reinforce trust across participating agencies.

The inclusion of this simulation strengthens the architectural plausibility of the framework by demonstrating

that informational sovereignty is institutionally implementable under defined governance constraints, without claiming empirical or statistical validation.

Within the design science paradigm, the prototype operates as a conceptual instantiation demonstrating architectural feasibility rather than system deployment. Its function is heuristic and explanatory.

➤ *Analytical Synthesis and Boundary Clarification*

The institutional diagnosis developed in this section aligns with the exploratory ISA score (≈ 0.37) presented in Section 5. Structural discontinuity constrains demographic integrity; partial embedding limits algorithmic capacity; and fragmented harmonization weakens governed interoperability.

The qualitative analysis and quantitative approximation converge analytically rather than causally. The DRC functions as a plausibility configuration illustrating how informational fragility constrains algorithmic governance in structurally layered institutional environments.

This section does not propose a reform program. Its purpose remains analytical, comparative, and theoretical.

The convergence between qualitative institutional diagnosis and quantitative approximation does not imply causal confirmation. Rather, it reinforces dimensional alignment between architectural theory and operational measurement, strengthening the internal empirical coherence of the framework.

VIII. DISCUSSION: STRUCTURAL PRECONDITIONS OF AI GOVERNANCE AND THE CONSTITUTIONAL ARCHITECTURE OF ALGORITHMIC SOVEREIGNTY

➤ *Beyond Algorithm Regulation: Infrastructural Preconditions of AI Governance*

Debates on AI governance in public administration have largely concentrated on regulatory instruments: transparency mandates, algorithmic audits, fairness metrics, and explainability requirements. While normatively indispensable, such frameworks often presuppose consolidated informational infrastructures capable of sustaining algorithmic decision-making.

This observation aligns with recent AI governance scholarship emphasizing institutional capacity and governance design as critical determinants of responsible AI implementation in the public sector (Sun & Medaglia, 2023).

This study challenges that presupposition.

Algorithmic governance is not merely a question of regulating deployed systems. It is structurally conditioned by the epistemic reliability of demographic infrastructures. Where population registries are fragmented, incomplete, or

institutionally siloed, algorithmic systems cannot operate coherently regardless of regulatory sophistication.

Informational fragility thus operates as a structural constraint on AI governance feasibility.

This shifts the analytical focus from *how to regulate algorithms* to *under what institutional conditions algorithmic governance becomes viable*.

➤ *Institutional Feasibility as a Missing Variable in AI Governance Literature*

Current AI governance scholarship emphasizes:

- Ethical AI frameworks
- Bias detection and mitigation
- Algorithmic transparency
- Human-in-the-loop oversight

However, these mechanisms presuppose:

- Reliable underlying datasets
- Stable interoperability channels
- Institutionalized analytical capacity

The GPAS framework introduces institutional feasibility as a prior analytical layer.

Without structural integrity, bias audits cannot correct systemic data absence.

Without governed interoperability, transparency may coexist with executive overreach.

Without institutional embedding, AI strategies remain declarative rather than operational.

AI governance is therefore institutionally conditional.

This study contributes a structural theory of algorithmic feasibility, positioning informational coherence as a necessary precondition for legitimate AI deployment in public administration.

➤ *Digital Constitutionalism and the Redistribution of Informational Authority*

Digital constitutionalism scholarship argues that fundamental rights protections must be embedded within digital infrastructures rather than retrofitted after deployment (Celeste, 2021). Algorithmic systems reshape administrative authority by redistributing informational control.

Informational consolidation enhances coordination capacity but simultaneously centralizes informational authority. This produces a constitutional tension between efficiency and pluralism.

The concept of algorithmic sovereignty advanced in this article intersects with digital constitutionalism in a structural manner. Governed Interoperability represents the institutional

mechanism through which constitutional safeguards are operationalized.

Data protection legislation, independent supervisory authorities, and auditability infrastructures are not secondary normative add-ons; they are structural components of algorithmic sovereignty.

Algorithmic sovereignty without constitutional embedding risks evolving into technocratic concentration.

Thus, digital constitutionalism is not external to institutional architecture; it is constitutive of it.

The consolidation of informational infrastructures may therefore be understood as a constitutional moment in digital governance, redefining the locus of administrative authority and reshaping the separation of powers in algorithmically mediated states.

➤ *Centralization, Pluralism, and Democratic Stability*

Institutional integration produces a structural trade-off:

- Enhanced interoperability increases administrative coherence.
- Yet it may reduce institutional pluralism.

In consolidated digital states, constitutional oversight mechanisms mitigate concentration risks. In information-fragile contexts, however, consolidation may outpace normative stabilization.

The GPAS framework conceptualizes sovereignty as architectural balance rather than centralization.

Algorithmic sovereignty emerges when structural integrity, analytical embedding, and normative governance evolve in equilibrium.

This architectural equilibrium becomes a condition for democratic stability in algorithmically mediated governance environments.

➤ *Infrastructural Dependency and Sovereignty under Platform Capitalism*

Digital transformation increasingly unfolds within global platform ecosystems and through the expansion of Digital Public Infrastructure (DPI) initiatives aimed at building foundational digital identity, payment, and data exchange systems (G20, 2023). Vendor lock-in, proprietary infrastructures, and transnational data architectures complicate state autonomy.

While DPI frameworks emphasize scalability and inclusion, they often under-theorize the institutional preconditions necessary to sustain interoperable and accountable demographic infrastructures.

Algorithmic sovereignty, as theorized here, does not imply technological autarky. It implies institutional control over governance processes.

Sovereignty requires:

- Regulatory authority over technology providers
- Domestic analytical capacity
- Institutional oversight of algorithmic infrastructures

Without these capacities, informational consolidation may coexist with infrastructural dependency.

Thus, infrastructural autonomy constitutes a dimension of digital constitutionalism and algorithmic sovereignty alike.

➤ *Expanding State Capacity Theory: Informational Capacity as a Structural Layer*

Classical state capacity theory traditionally emphasizes coercive, fiscal, and administrative dimensions. This study proposes informational capacity as a distinct structural layer.

Informational coherence enhances:

- Fiscal planning precision
- Electoral legitimacy
- Territorial coordination

Yet informational fragility constrains each of these domains.

By introducing informational capacity as an analytical dimension, this study expands fragile state theory without reducing governance to technological determinism.

➤ *Political Economy of Algorithmic Sovereignty*

Algorithmic sovereignty should not be understood solely as an institutional or technical configuration, but as a deeply political process embedded in power relations and governance structures.

The consolidation of demographic infrastructures and the development of interoperable systems fundamentally alter informational asymmetries within the state. Institutions that historically controlled sector-specific data—such as electoral commissions, migration authorities, or security agencies—may experience a reduction in informational autonomy.

This redistribution of informational power creates potential resistance dynamics, as bureaucratic actors may strategically preserve fragmentation to maintain institutional influence.

Consequently, the transition toward algorithmic sovereignty is not a linear administrative reform but a negotiated political transformation involving competing institutional interests, governance trade-offs, and strategic adaptation.

This transformation reshapes not only inter-institutional relations but also the relationship between the state and citizens in the production and governance of population data.

The preceding analysis demonstrates that algorithmic governance cannot be reduced to technical deployment or

regulatory design alone. It is fundamentally embedded in institutional configurations and political dynamics that shape state capacity.

These dynamics also raise critical questions regarding democratic accountability, as the centralization of informational infrastructures may strengthen state capacity while simultaneously increasing the risk of executive dominance if not balanced by robust oversight mechanisms.

➤ *Theoretical Synthesis*

This research advances three overarching theoretical claims:

- Algorithmic governance is structurally conditional upon informational coherence.
- Digital sovereignty is an architectural property of institutional balance.
- AI governance must be analyzed through infrastructural preconditions rather than regulatory instruments alone.

Algorithmic systems do not generate sovereignty. Institutional architecture does.

➤ *Toward a Theory of Informational Statehood*

The concept of informational fragility suggests a broader theoretical implication: contemporary statehood may increasingly depend on informational consolidation as a structural dimension of authority. Just as fiscal extraction defined early modern state capacity, demographic consolidation may define algorithmic-era statehood. This perspective invites future research to conceptualize informational capacity as a constitutive element of state formation rather than a derivative feature of digital modernization.

IX. POLICY IMPLICATIONS

➤ *From Digital Modernization to Institutional Sequencing*

The findings of this study suggest that policymakers in a state experiencing informational fragility should shift the focus of digital transformation from technological acceleration to institutional sequencing.

Digital government reforms often prioritize visible technological deployment—such as biometric registration systems or AI-based analytics platforms—without first stabilizing demographic infrastructures. This sequencing may generate temporary modernization effects while reinforcing structural incoherence.

The framework developed here indicates that demographic stabilization constitutes a foundational stage. Policymakers should therefore:

- Prioritize registry consolidation before analytics scaling,
- Establish interoperability governance before predictive automation,
- Embed oversight mechanisms prior to algorithmic expansion.

Such sequencing does not imply technological delay; rather, it enhances sustainability.

➤ *Institutional Capacity-Building over Technological Procurement*

A second implication concerns procurement strategies.

In many developing contexts, digital identity systems are implemented through external vendors offering turnkey solutions. While such approaches may accelerate deployment, they often leave domestic institutions dependent on proprietary infrastructures.

The analysis presented here suggests that algorithmic sovereignty depends less on technological sophistication than on institutional embedding. Policy emphasis should therefore shift toward:

- Internal analytical capacity-building,
- Regulatory strengthening,
- Cross-ministerial coordination mechanisms,
- Development of domestic expertise.

Without institutional embedding, technological infrastructures may remain externally mediated and politically fragile.

➤ *Democratic Safeguards and Oversight Architecture*

Algorithmic governance introduces risks related to transparency, accountability, and bias.

Policy frameworks should integrate:

- Independent data protection authorities,
- Clear audit trails for algorithmic decision systems,
- Legal provisions ensuring citizen contestability,
- Parliamentary or judicial oversight mechanisms for interoperability frameworks.

Informational consolidation should not result in executive concentration of authority.

The governance of interoperability is as important as its technical implementation.

➤ *Managing Bureaucratic Resistance and Institutional Incentives*

Institutional integration often disrupts established power balances.

Policy strategies must recognize that:

- Fragmentation may protect organizational autonomy,
- Agencies may resist harmonization,
- Interoperability reforms may alter budgetary and political influence.

Therefore, reform processes should incorporate:

- Negotiated institutional alignment,

- Phased integration models,
- Incentive structures encouraging cooperation,
- Mechanisms to protect institutional legitimacy.

Reform design must be politically informed rather than purely technocratic.

➤ *Addressing Digital Dependency and External Partnerships*

In contexts where digital infrastructure relies heavily on external providers, policymakers face sovereignty dilemmas.

While international partnerships are often necessary, contractual and regulatory frameworks should ensure:

- Data localization where legally appropriate,
- Transparency in vendor governance structures,
- Domestic capacity transfer requirements,
- Long-term infrastructural sustainability.

Algorithmic sovereignty, as conceptualized here, requires institutional control over governance processes—even when technological components are externally sourced.

➤ *Caution Against Technocratic Overreach*

Finally, policymakers should avoid framing algorithmic governance as a panacea for broader state fragility.

Informational coherence enhances administrative capacity, but it does not automatically resolve:

- Fiscal instability,
- Political contestation,
- Legitimacy crises,
- Security challenges.

Algorithmic sovereignty is structurally enabling, not politically substitutive. Maintaining this distinction is essential to prevent overextension of digital reform narratives.

➤ *Generalizable Lessons for Digital Government Reform*

Although illustrated through African contexts, the policy insights derived here are relevant to any state undergoing digital transformation under conditions of institutional fragmentation.

Three general principles emerge:

- Prioritize structural integrity over rapid automation.
- Govern interoperability normatively, not merely technically.
- Treat algorithmic capacity as institutional embedding rather than tool acquisition.

These principles encourage a governance-centered approach to digital transformation.

X. METHODOLOGICAL LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

➤ *Measurement Constraints*

The ISA relies on publicly available international indicators to ensure transparency and replicability. However, such indicators inevitably simplify complex institutional realities.

Birth registration rates do not fully capture qualitative registry integrity. The Online Service Index measures digital service provision rather than direct algorithmic embedding. Legal interoperability coding reduces multifaceted regulatory ecosystems to ordinal scores.

These simplifications are analytically necessary but theoretically bounded.

➤ *Indicator Proxy Limitations*

Several ISA components rely on proxy indicators rather than direct measures of algorithmic governance embedding.

For instance:

- The presence of national AI strategies does not guarantee implementation.
- Data protection legislation does not ensure enforcement effectiveness.
- Online service provision does not directly measure predictive modeling integration.

Future research should refine these proxies through:

- Survey-based institutional embedding measures
- Administrative data access
- Expert-coded governance indices

➤ *Sample Size and Statistical Generalizability*

The cross-national calibration presented in this study is exploratory. While the ten-country sample ensures structural contrast, it does not support causal inference or global generalization.

Future studies should:

- Expand ISA calibration to larger-N datasets
- Conduct longitudinal panel analyses
- Apply multivariate modeling to test causal hypotheses

➤ *Aggregation Sensitivity*

Although robustness tests demonstrate ordering stability under moderate weighting perturbations, composite indices remain sensitive to aggregation logic.

Alternative methodological approaches could include:

- Principal Component Analysis
- Bayesian weighting models
- Structural Equation Modeling

Such extensions would enhance statistical precision while preserving theoretical alignment.

➤ Normative Boundary Clarification

The ISA measures informational coherence, not democratic quality or overall state capacity. High ISA values do not guarantee political legitimacy, fiscal stability, or human rights compliance.

Algorithmic sovereignty is a necessary but not sufficient condition for broader governance consolidation.

This boundary clarification prevents conceptual overextension.

➤ Future Research Agenda

Future research should:

- Conduct longitudinal ISA tracking
- Investigate causal relationships between informational consolidation and governance outcomes
- Analyze constitutional litigation involving algorithmic systems
- Explore political economy dynamics of interoperability reform

The present study establishes a structural foundation upon which such empirical extensions can build.

XI. CONCLUSION

This article develops a political-institutional analysis of the structural preconditions of algorithmic sovereignty in contexts characterized by fragmented demographic infrastructures. By introducing the concept of informational fragility, it has identified a foundational constraint in contemporary AI governance debates: the implicit presumption that coherent, integrated, and interoperable demographic systems already exist.

Grounded in a Design Science Research approach, the study advanced the Sovereign Algorithmic Population Governance (GPAS) framework as an institutional architecture composed of three interdependent pillars—Structural Integrity, Institutionalized Algorithmic Capacity, and Governed Interoperability. These pillars specify the structural conditions under which algorithmic sovereignty may emerge as a legitimate and operational property of public authority.

The exploratory operationalization of the Algorithmic Sovereignty Index (ISA) demonstrated that the conceptual architecture can be translated into measurable institutional dimensions without collapsing into existing digital maturity indicators. The illustrative case of the Democratic Republic of Congo further showed how layered informational fragmentation constrains demographic consolidation, interoperability governance, and analytical embedding.

The analysis demonstrates that algorithmic sovereignty is not a technological achievement but an institutional condition. AI governance is therefore structurally conditional upon informational coherence. Without demographic stabilization and normatively governed interoperability, predictive systems risk reinforcing fragmentation rather than strengthening public authority.

By conceptualizing informational consolidation as a distinct layer of state capacity, this study extends digital government scholarship and contributes to a structural theory of AI governance. Informational coherence should thus be treated as a foundational dimension of algorithmically mediated statehood, shaping the feasibility, legitimacy, and constitutional architecture of AI-driven public administration.

➤ Declaration of Interest

The author declares that there are no conflicts of interest regarding the publication of this article.

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