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Article

Low-Cost, Modular, and Scalable IT Architectures for Public Sector Digital Governance: A Systematic Literature Review and the DG-LITE Framework

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Abstract: Public-sector digital governance requires IT architectures that are sustainable, scalable, and adaptable within fiscal and institutional constraints. While cloud computing, blockchain, and artificial intelligence influence system design, empirical synthesis of implemented architectures is limited. This study presents a systematic literature review of 26 implemented public-sector IT systems published between 2020 and 2026. Following PRISMA 2020 guidelines, records were retrieved via Google Scholar using Publish or Perish and coded by sector, architecture type, technology stack, workflow automation, and evaluation methods. Findings indicate centralized (26.9%) and modular/enterprise architectures (23.1%) dominate, while decentralized (15.4%) and AI-native systems (15.4%) are emerging. National agencies favor modular integrated systems, whereas LGUs rely on centralized web-based designs. Technology trends show web-centric systems, growing cloud adoption, blockchain experimentation, and AI/RPA integration. Evaluation emphasizes functional testing and usability, with limited governance-impact assessment. Based on these insights, the DG-LITE framework is proposed for low-cost, scalable, and evaluation-ready digital governance systems.
Keywords: digital governance; IT architecture; modular system; blockchain; workflow automation; DG-LITE

1. Introduction

Digital governance transformation extends beyond technological adoption to the structural reconfiguration of public-sector information systems. Governments increasingly deploy IT platforms to automate workflows, enhance transparency, and improve service delivery; however, the sustainability and scalability of these initiatives depend fundamentally on architectural design rather than technological novelty alone.

Enterprise Architecture (EA) frameworks such as TOGAF and the Zachman Framework emphasize layered separation of concerns to support maintainability and scalability, while modular systems theory highlights the role of architectural decoupling in enabling adaptive evolution. Institutional and socio-technical perspectives further suggest that public-sector system design is shaped by governance requirements, resource constraints, and organizational context rather than purely technical optimization.

Recent research on smart and sustainable cities underscores the importance of integrated digital infrastructures that support interoperability, scalability, and data-driven governance. These insights reinforce the need for architecture-level approaches that align system design with governance objectives, particularly in resource-constrained environments such as Local Government Units (LGUs) and State Universities and Colleges (SUCs).

Despite growing investments in digital governance, a gap remains between technology adoption narratives and architectural implementation realities. Existing studies often emphasize policy frameworks, maturity models, and emerging technologies, while providing limited analysis of how systems are structurally designed, integrated, and evaluated in practice.

This study addresses this gap by conducting a systematic review of implemented public-sector IT systems to identify architectural patterns, sectoral variation, technology trends, and evaluation practices. Based on these insights, the DG-LITE framework is proposed as a layered, modular, and evaluation-oriented architectural synthesis for low-cost and scalable digital governance.

Unlike prior work, this study focuses on implemented systems and provides a practical, architecture-level blueprint that supports incremental modernization, interoperability, and governance-oriented evaluation.

2. Materials and Methods

Descriptive statistics were computed from the Excel dataset (n = 26). Cross-tabulations were examined to identify patterned variation across architecture categories and sectors. Due to the small sample size and heterogeneous category distribution, inferential statistical testing was not performed. Analysis remained descriptive and comparative.

Coding categories were iteratively refined to reduce ambiguity in classification. Only studies describing implemented or prototyped systems with identifiable architecture, technology stack, workflow elements, and evaluation components were included.

In cases where studies exhibited hybrid characteristics across multiple architectural categories, the dominant architectural orientation was determined based on the primary structural design rather than peripheral technological features. Coding definitions were iteratively refined to ensure consistency across classification.

2.1. Screening Process

This systematic literature review followed the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparent and replicable study identification, screening, eligibility assessment, and inclusion.

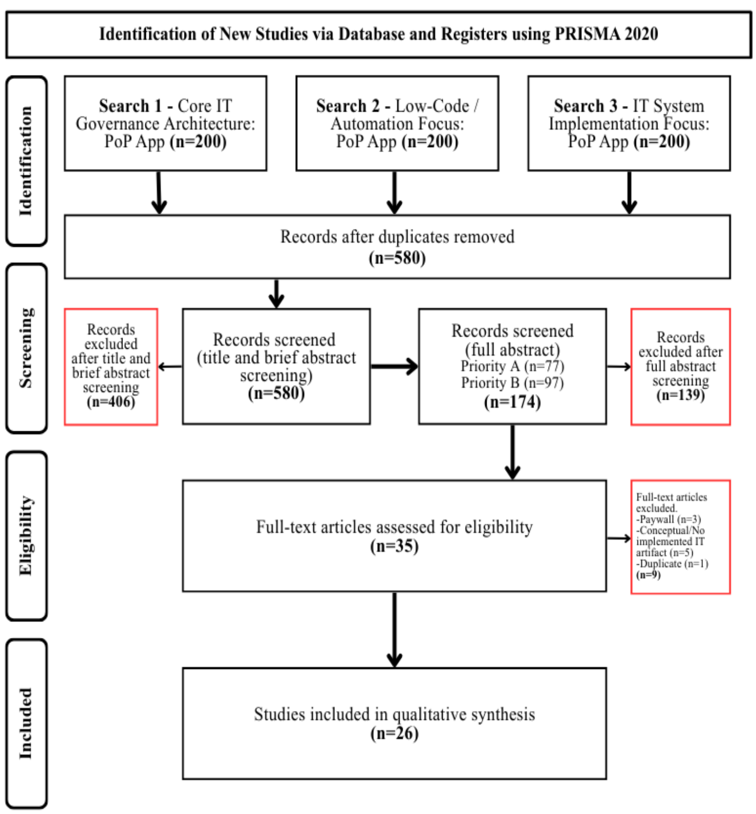

Figure 1. PRISMA 2020 flow diagram of study selection process.

The diagram illustrates the systematic screening process applied in this review. A total of 600 records were identified through database searching using Google Scholar via Publish or Perish. After removal of duplicates (n =

20), 580 records were screened at title level. Following title and abstract screening, 35 full-text articles were assessed for eligibility. Nine studies were excluded after full-text review due to insufficient architectural or implementation detail. Twenty-six studies met all inclusion criteria and were included in the final qualitative synthesis.

2.1.1 Identification

A structured search was conducted using Google Scholar via the Publish or Perish application. Three focused search strategies targeting digital governance architecture, system implementation, workflow automation, and low-code/automation platforms were applied. The search yielded 600 records.

Search 1 - Core IT Governance Architecture:

("digital governance" OR "e-government" OR "digital government") AND

("system architecture" OR "workflow automation" OR "cloud computing") AND

("public sector" OR "local government" OR "government agency")

Search 2 - Low-Code / Automation Focus:

("digital governance" OR "e-government")AND

("low-code" OR "no-code" OR "serverless" OR "automation platform")AND

("public sector" OR "local government")

Search 3 - IT System Implementation Focus:

("e-government system" OR "digital governance platform")AND

("implementation" OR "design" OR "evaluation")

2.1.2 Screening Process

After removing duplicates, studies were screened based on relevance to implemented public-sector IT systems with identifiable architecture, technology stack, workflow components, and evaluation methods. Conceptual, policy-only, and survey-based studies were excluded. A total of 26 studies met all inclusion criteria and were included in the final synthesis.

Data were extracted and coded based on sector, architecture type, technology stack, workflow/automation, and evaluation approach. Where studies exhibited hybrid characteristics, dominant architecture was determined based on core system structure, data flow, and module dependency.

Descriptive statistics and cross-tabulations were used to identify architectural patterns, sectoral variation, and technology trends. Due to the limited sample size and heterogeneous categories, analysis remained qualitative and comparative rather than inferential.

2.1.3 Full-Text Eligibility Assessment

Full texts of the 35 studies were retrieved and assessed for eligibility. Studies were excluded at this stage if they:

- Lacked detailed system architecture description,
- Did not provide evidence of implementation (prototype, pilot, or deployment),
- Failed to identify technology stack or system components,
- Provided insufficient evaluation or testing evidence,
- Were purely descriptive without technical artifacts.

A total of 9 studies were excluded after full-text assessment due to insufficient architectural or implementation detail.

2.1.4 Final Inclusion

The final dataset consisted of 26 studies, all describing implemented public sector IT systems with identifiable architecture, technology stack, workflow components, and evaluation indicators.

2.2 Data Extraction and Coding Framework

Extracted variables included: Sector, Year, Architecture Type, Technical Stack/Technology, Workflow/Automation focus, Implementation Type, Evaluation/Testing, and DG-LITE relevance indicators. Coding definitions were iteratively refined to reduce ambiguity. Where studies included mixed characteristics, dominant architectural orientation was identified based on structural description.

2.3 Risk of Bias and Limitations

This review is limited to Google Scholar-indexed publications and English-language studies, which may introduce database and language bias. The final sample size (n = 26) constrains statistical generalization. Variability in architectural reporting detail across studies may affect classification granularity. Future research should incorporate multi-database retrieval and quantitative benchmarking validation of proposed architectural models. All authors declare that they have no conflicts of interest.

While the final sample consists of 26 implemented systems, the study adopts a qualitative-analytical systematic review approach, where the objective is pattern identification rather than statistical generalization.

In digital governance research, particularly in emerging architectural domains, implemented system studies with full technical details are limited, justifying a focused dataset with strict inclusion criteria.

To enhance analytical rigor despite the small sample size:

- cross-tabulation analysis was complemented by pattern convergence analysis,
- architectural classifications were refined iteratively with explicit dominance criteria, and
- findings were interpreted as analytical tendencies rather than statistically generalizable claims.

Future studies are recommended to extend this work using multi-database datasets and inferential statistical validation.

2.4 Coding Schema

To reduce ambiguity in classification, explicit coding rules were applied across all reviewed studies. Centralized architectures were defined as systems with a single core structure controlling both data and logic, typically implemented through monolithic or MVC-based designs. In contrast, modular or enterprise architectures refer to systems composed of independently deployable modules or integrated enterprise-wide components that support scalability and extensibility.

Service-oriented architectures (SOA) were identified as systems structured around interoperable services, commonly exposed through application programming interfaces (APIs). Decentralized or distributed architectures include systems utilizing blockchain technologies, distributed databases, or peer-to-peer configurations, where control and data are not centrally managed. Hybrid architectures were classified as systems combining multiple architectural approaches, provided that no single architecture accounts for more than 60% of the overall system design. Finally, AI-native architectures were defined as systems in which artificial intelligence or machine learning components are integral to core system logic rather than serving as auxiliary features.

To ensure consistency in classification, a dominant architecture rule was applied. Each system was categorized based on its primary structural characteristics, considering the overall control mechanism, data flow architecture, and dependency relationships among system components. This approach minimizes subjectivity and ensures uniform classification across studies.

3. Results

3.1 Architectural Dominance in Public-Sector Digital Governance Systems

Table 1. Distribution of Architecture Categories (n = 26)

Architecture Category	Count	%
Centralized	7	26.9%

Modular / Enterprise	6	23.1%
Service-Oriented	3	11.5%
Decentralized / Distributed	4	15.4%
Hybrid	2	7.7%
AI-Native	4	15.4%
Total	26	100%

Centralized architectures (26.9%) are the most common, followed by modular/enterprise systems (23.1%), indicating a transition toward scalable designs. The dominance of centralized systems suggests that governments may prioritize administrative control and predictability over distributed autonomy. However, the near-equal presence of modular architectures signals a shift toward scalable transformation models.

3.2 Sectoral Variation in Architectural Design and Deployment Strategies

Table 2. Architecture Type by Sector

Sector	Centralized	Modular	SOA	Decentralized	Hybrid	AI-Native	Total
National Gov	1	4	1	1	1	1	9
LGU	4	1	0	0	0	0	5
SUC	1	1	1	0	0	2	5
Public Safety	1	0	1	3	1	1	7
Total	7	6	3	4	2	4	26

Sector	Dominant Architecture	Emerging Architecture	Notes
National Government	Modular / Enterprise	Cloud + AI	Large-scale integration needs
LGU	Centralized Web-Based	Low-Code	Budget-constrained environments
SUC (State Universities)	Modular + AI	RAG / ML	Research-driven experimentation
Public Safety	Distributed / IoT	Blockchain	Real-time and sensor-driven needs

National Government systems tend to adopt modular and enterprise architectures due to scale, inter-agency interoperability, and national data integration demands. Local Government Units (LGUs) predominantly use centralized web-based architectures due to budget constraints and limited technical manpower. State Universities and Colleges (SUCs) show greater experimentation with AI, ML, and RAG systems, likely influenced by research-oriented environments. Public Safety systems require distributed architectures, IoT integration, and real-time automation, reflecting operational urgency.

Architecture sophistication appears associated with sectoral funding capacity and operational complexity. Centralization dominates at local levels, while modularity and AI emerge in research-intensive and national contexts.

3.3 Evolution of Technology Stacks and Automation Trends in Digital Governance

Table 3. Technology Trend Classification

Technology Trend	Frequency	%
Web-Based Systems	6	23%
Cloud / SaaS	4	15%
AI / ML	5	19%

RPA / Cognitive Automation	2	8%
Agentic / RAG	2	8%
Blockchain	1	4%
IoT	1	4%
API Integration / SOA	3	11%
Distributed Database	2	8%
Total	26	100%

Note: Technology categories are non-mutually exclusive, as many systems integrate multiple technologies. Frequencies represent presence within systems, not exclusive classification. Therefore, percentages reflect relative occurrence rather than total system distribution.

Technology trends indicate a transition from web-based systems toward cloud integration and intelligent automation (AI/ML and RPA), while blockchain and IoT remain niche but strategic. These patterns suggest a transitional ecosystem characterized by incremental modernization rather than full architectural transformation.

3.4 Evaluation Approaches in Implemented Systems: Practices and Persistent Gaps

Table 4. Evaluation Methods Used

Evaluation Method	**Count**	**Percentage (%)**
Performance Testing (throughput, latency)	6	23.1%
Algorithm / Model Validation (accuracy, F1, classification)	4	15.4%
Usability Testing	4	15.4%
Functional Testing	3	11.5%
Security Testing	1	3.8%

Evaluation practices are primarily focused on technical validation rather than governance sustainability. Performance testing (23.1%) is the most common, followed by algorithm/model validation and usability testing (15.4% each). Functional testing is less frequent (11.5%), while security testing is minimal (3.8%).

Key evaluation dimensions such as cost-efficiency, scalability stress testing, and longitudinal governance impact are largely absent. This indicates that current practices remain system-centric and short-term, reinforcing the need for integrated and continuous evaluation as proposed in the DG-LITE Evaluation Overlay.

4. Discussion

This study analyzes implemented public-sector digital governance systems to identify architectural patterns, sectoral variation, and evaluation gaps. While the findings are derived from a limited but rigorously screened dataset, they offer important insights into how digital governance systems are currently designed and evolved in practice.

4.1 From Descriptive Patterns to Conditional Explanations

The results indicate that centralized and modular architectures dominate across the reviewed systems. Rather than interpreting this as a universal characteristic of digital governance, the pattern can be more cautiously understood as context-dependent architectural preference shaped by institutional and operational conditions.

For instance, Local Government Units (LGUs) predominantly employ centralized web-based systems. This pattern may be associated with constraints such as limited technical manpower, budget restrictions, and the need for simplified system control. In contrast, national-level systems and State Universities and Colleges (SUCs) exhibit greater adoption of modular and AI-integrated architectures, which may reflect higher institutional capacity, broader interoperability requirements, and access to technical expertise.

These observations suggest that architectural choices in digital governance are not purely technical decisions, but are influenced by organizational capacity, governance requirements, and resource availability. However, given that the dataset is based on published system descriptions, these interpretations should be viewed as analytically suggestive rather than causally conclusive.

4.2 Layered Expansion versus Structural Transformation

A key analytical insight emerging from the dataset is the distinction between incremental (layered) expansion and structural transformation.

Most systems reviewed appear to evolve through incremental layering, where new functionalities such as AI modules, APIs, or automation scripts are added onto existing centralized or modular systems. This pattern is evident in AI-enhanced workflows, cloud adoption, and API-based interoperability layered onto existing systems.

In contrast, fully transformative architectures, such as decentralized or AI-native systems, remain relatively limited and are often confined to specific use cases (e.g., public safety, blockchain-based audit systems).

This suggests that digital governance evolves through gradual, layered adaptation rather than abrupt structural replacement.

4.3 Evaluation Practices and the Sustainability Gap

The analysis further reveals that evaluation practices across implemented systems are predominantly technical and short-term in nature, focusing on performance, usability, and functional correctness.

While these evaluation methods are essential, they do not sufficiently address long-term sustainability, scalability, and governance impact. Notably absent are cost-efficiency assessment, longitudinal performance tracking, scalability stress testing, and governance-level metrics.

This creates a critical gap: systems may be technically functional but lack evidence of sustained effectiveness in real-world governance contexts.

The findings therefore highlight the need for evaluation frameworks that extend beyond system validation toward continuous, multi-dimensional assessment, particularly in public-sector environments where accountability and long-term service delivery are central.

4.4 Positioning the DG-LITE Framework as an Inductive Synthesis

Table 5. Empirical findings and DG-LITE Architectural Response

Empirical Finding	**DG-LITE Architectural Response**
Dominance of centralized systems	Supports incremental modular layering rather than full replacement
Limited interoperability across systems	Integration Layer standardizes API-based communication
Weak evaluation practices	Evaluation Overlay embeds continuous performance and governance metrics
Incremental adoption of emerging technologies	Optional modular AI/RPA components enable gradual integration

The DG-LITE framework is derived inductively from the recurring structural and evaluative patterns identified in this review. It should therefore be understood not as a fully validated prescriptive model, but as an exploratory and synthesis-oriented architectural framework grounded in observed implementation practices.

The framework responds directly to three key gaps identified in the findings:

1. Fragmented architectures → Layered modular structure DG-LITE introduces clearly defined layers (Presentation, Workflow, Integration, Data, Infrastructure) to support separation of concerns and incremental scalability.

2. Limited interoperability → Integration layer formalization The inclusion of an explicit Integration Layer addresses the observed lack of structured interoperability across systems.
3. Weak evaluation practices → Embedded Evaluation Overlay The cross-cutting Evaluation Overlay operationalizes continuous assessment across technical and governance dimensions.

Rather than replacing existing architectures, DG-LITE is designed to augment and reorganize existing systems, making it particularly suitable for environments where full system replacement is not feasible.

4.4.1 The DG-LITE Framework

The DG-LITE (Digital Governance – Layered, Integrated, Technology-Efficient) framework is proposed as an inductively derived architectural synthesis grounded in observed implementation patterns. It provides a layered, modular structure designed to support interoperability, scalability, and evaluation in resource-constrained public-sector environments.

Rather than replacing existing systems, DG-LITE enables incremental modernization through structured layering, integration mechanisms, and embedded evaluation. The framework is illustrated in Figure 2.

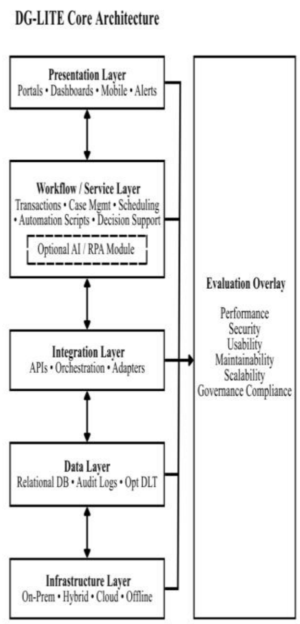

Figure 2. DG-LITE Framework for Scalable and Institutionally Sustainable Digital Governance

As illustrated in Figure 2, DG-LITE organizes digital governance systems into five structurally decoupled core layers supported by a cross-cutting Evaluation Overlay. The layered configuration reflects enterprise architecture principles, enabling separation of concerns while supporting incremental scalability. Vertical bidirectional flow between layers represents controlled interaction rather than rigid dependency, reinforcing modular extensibility.

The Evaluation Overlay spans all architectural layers, institutionalizing performance, usability, security, maintainability, scalability, and governance compliance metrics. By embedding evaluation structurally rather than treating it as a post-deployment activity, DG-LITE addresses the sustainability gap identified across existing systems.

4.4.2 Technical Architecture Specification

To enhance practical applicability, DG-LITE defines inter-layer communication and modular boundaries through standardized interfaces. The Presentation and Workflow layers interact via REST/HTTP APIs or GraphQL endpoints, while the Workflow and Integration layers are coordinated through API gateways or message queues (e.g., REST, MQTT, RabbitMQ). The Integration and Data layers communicate using structured queries (SQL/NoSQL) supported by standardized data schemas, while the Infrastructure layer enables deployment through containerized or lightweight server environments.

To maintain modularity, each component operates independently, exposes API endpoints, and maintains minimal coupling with other modules. This architectural approach supports incremental system expansion without requiring full redesign, making it suitable for resource-constrained environments such as LGUs and SUCs.

4.4.3 Operationalizing the Evaluation Overlay

The Evaluation Overlay is operationalized through measurable indicators across system layers, including performance (e.g., latency and throughput), usability (e.g., SUS, UEQ), scalability (e.g., load testing and concurrent users), and security (e.g., vulnerability assessment and authentication protocols). In addition, governance impact is assessed through indicators such as service processing time reduction, transaction transparency, and user adoption rates.

For longitudinal evaluation, systems are expected to log transaction metrics, monitor service efficiency trends, and track adoption and operational improvements over time. This approach extends beyond ISO/IEC 25010 by incorporating governance-level impact indicators, addressing a key gap in existing evaluation practices.

4.4.4 Illustrative Case Application

DG-LITE can be applied through incremental transformation, where centralized systems evolve by introducing API-based integration and modular services. This approach enables gradual modernization with minimal disruption while preserving existing infrastructure.

5. Conclusion

This study analyzed 26 implemented public-sector IT systems to identify architectural patterns, sectoral variation, technology trends, and evaluation practices. Findings indicate that centralized and modular architectures dominate current implementations, while decentralized and AI-native systems remain emerging. Technology evolution reflects incremental modernization, and evaluation practices remain primarily technical rather than sustainability-oriented.

The DG-LITE framework provides a layered, modular, and scalable architectural blueprint grounded in empirical findings, offering a practical and implementation-oriented pathway for low-cost, interoperable, and evaluation-ready digital governance systems.

Future research should validate DG-LITE through real-world implementation and longitudinal assessment of governance impact. Sustainable digital governance requires architectural discipline aligned with institutional feasibility and measurable public value.

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