



From Digital Fragmentation to Digital State Capacity: Institutional, Regulatory, and Infrastructural Conditions for Digital Government Transformation in Libya

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من التشرذم الرقمي إلى قدرة الدولة الرقمية: الشروط المؤسسية والتنظيمية والبنية التحتية لتحول
الحكومة الرقمية في ليبيا

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Abstract:

More contemporary research defines digital government not merely as the automation of administrative processes, but as a fundamental transformation in public sector governance. This paper investigates digital government development in Libya, a context characterized by institutional fragmentation, ambiguous regulatory environments, and infrastructural disparities. Adopting a PRISMA-based systematic review, this study integrates the Technology-Organization-Environment (TOE) framework with the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). We propose "Digital State Capacity" as a focal concept, identifying seven critical hierarchical domains: institutional coordination, regulatory preparedness, infrastructural resilience, skilled human capital, interoperable systems, cybersecurity, and public trust. The findings suggest that digital transformation in fragile states requires a sequential approach, where foundational governance and legislative clarity precede advanced service integration. This study provides a phased policy roadmap and an evaluation matrix to guide Libya's transition from fragmented digital efforts to a cohesive, resilient digital state system.

Keywords: Digital government, digital transformation, digital state capacity, e-government, Libya, TOE framework, public administration.

الملخص

لم يعد مفهوم الحكومة الرقمية مقتصرًا على أتمتة الإجراءات الإدارية فحسب، بل أصبح يمثل تحولًا جوهريًا في طبيعة الإدارة العامة. تستقصي هذه الورقة تطور الحكومة الرقمية في ليبيا، في ظل سياق يتسم بالتشردم المؤسسي، وضبابية الأطر التنظيمية، والفجوات في البنية التحتية. من خلال مراجعة منهجية قائمة على معايير (PRISMA)، يدمج هذا البحث إطار (TOE) مع نموذج قبول التكنولوجيا (TAM) والنظرية الموحدة لقبول واستخدام التكنولوجيا (UTAUT). يقدم البحث مفهوم "قدرة الدولة الرقمية" (Digital State Capacity) كمحور تحليلي، محددًا سبع نطاقات هرمية حرجية: التنسيق المؤسسي، الجاهزية التنظيمية، مرونة البنية التحتية، رأس المال البشري المؤهل، الأنظمة القابلة للتشغيل البيئي، الأمن السيبراني، والثقة العامة. تشير النتائج إلى أن التحول الرقمي في الدول الهشة يتطلب نهجًا تسلسليًا، حيث تسبق الحوكمة التأسيسية والوضوح التشريعي عمليات تكامل الخدمات المتقدمة. توفر هذه الدراسة خارطة طريق سياساتية مرحلية ومصفوفة تقييم لتوجيه انتقال ليبيا من الجهود الرقمية المشتتة نحو نظام دولة رقمي متماسك ومرن.

الكلمات المفتاحية: الحكومة الرقمية، التحول الرقمي، قدرة الدولة الرقمية، الحكومة الإلكترونية، ليبيا، إطار (TOE)، الإدارة العامة.

1. Introduction

Public administration is increasingly being reconfigured through digital technologies, a goal shared by nations worldwide. Governments at all income levels are leveraging combined platforms, electronic identification systems, shared records for civil and business use, online infrastructure, and data-driven smart administrative procedures to transform the delivery of public services (OECD, 2020). However, comparative public administration literature indicates that digitization does not inherently equate to institutional improvement. Genuine digital government reform requires a paradigm shift in how institutions are organized, how regulatory frameworks are constructed, and how the state interacts with the governed.

In the Libyan context, this digital transition occurs within a complex bureaucratic environment characterized by competing authorities, lagging legislative frameworks, and significant regional disparities in infrastructure (Wynn et al., 2021; USAID, 2022). Previous investigations into local government have revealed that outdated software, poor internet connectivity, a lack of competent staff, and irregular financial support serve as persistent barriers to m-government initiatives (Wynn et al., 2021). Furthermore, structural weaknesses, such as fragmented electronic payment systems and inadequate cybersecurity, continue to undermine institutional digital maturity (USAID, 2022). Despite these challenges, research has increasingly focused on specific drivers of efficiency, such as the adoption of cloud computing and digital banking platforms among private sector employees (Alatresh, 2021; Alatresh et al., 2022). Additionally, the integration of web-based systems has been explored as a means to overcome legacy infrastructure limitations (Alatresh, 2008).

Beyond general administrative efficiency, the digital transition has profoundly impacted higher education, where studies show significant effects on the operational workflows and academic performance of faculty members (AlSharaa et al., 2026). However, the rapid adoption of new technologies—including Internet of Things (IoT) frameworks, smart city information systems, and artificial intelligence-driven diagnostic tools—has introduced paramount challenges regarding security and privacy (Shouran et al., 2025; Said et al., 2024). These developments underscore the dual nature of digital transformation in Libya: the emergence of innovative opportunities alongside inherent vulnerabilities that require robust, secure implementation frameworks (Said et al., 2024; Shouran et al., 2025).

A notable paradox exists between these structural challenges and Libya's performance on international metrics. The United Nations E-Government Survey (2024) indicates that Libya ascended from the "Middle" to the "High" E-Government Development Index (EGDI) bracket between 2022 and 2024 (United Nations, 2024). While this progress signifies advancement in service availability and telecommunications, it often masks deeper systemic issues regarding technical quality, legal security, and institutional capacity for long-term sustainability. While recent research utilizing the TOE framework and UTAUT model has contributed to understanding e-government adoption at the individual and organizational levels (Shwehdy, 2025), there remains a lack of holistic understanding regarding how decentralized government capacity at multiple scales influences state performance.

This article addresses this gap by reinterpreting Libya's digital government struggle through the lens of state capacity. Rather than treating infrastructure, legislation, and digital service adoption as disconnected elements, this study conceptualizes them as interdependent components of "Digital State Capacity"—the government's ability to develop, provide, and sustain digital services over time.

Research Questions

- **RQ1:** What Are the Institutional, Regulatory, Technological, and Organizational Contexts of the Digital Government Situation in Libya?
- **RQ2:** Which structural barriers are most frequently identified in Libyan related literature, policies, and systems, towards/digital transitioning?
- **RQ3:** In what way can inter-institutional fragmentation, ambiguous rules and poor infrastructure influence the sustainability and long-term viability of digital government initiatives?
- **RQ4:** Is there a means to integrate the TOE framework, TAM, and UTAUT in a single explanatory model of digital transformation at three Levels of Analysis – (a) the macro or institutional level, (b) the middle or organizational level, and (c) the micro or individual user level – concurrently?
- **RQ5:** What sort of governance model and implementation framework is needed to support capacity building of a distantly managed digital service in Libya, and to sustain a distant model of digital government strategy development?

2. Literature Review and Conceptions

2.1 E-Government and Digital Government Transformation

Initial research into e-government was too much focused on making government information available online and designing a website as a focal point for information provision. Over the past two decades, the attention of the field has been shifted to digital government under the broader rubric of public sector reform (digital by design), not only how government works but how government delivers services and conducts business – not only websites (OECD, 2020). This shift is particularly significant in regions with divided institutions, where an online portal can make the portion of a service that citizens directly use simpler and more digital, the behind-the-scenes processes are still performed manually, with ink signatures, with databases that are not integrated with one another. The effect is like a digital layer – a veneer of modernization that obscures, rather than addresses, the fractured units of the organization beneath.

2.2 Digital State Capacity – A Working Definition

Digital State Capacity captures the state's structural capacity to develop, regulate, and maintain a public ICT infrastructure, a layer of interoperable data infrastructure, and the social capacity to translate these technological resources into public value (Healy et al., 2026). In this study, digital state capacity is defined to encompass six interrelated pillars of which are institutional governance and coordination, regulatory and legislative preparedness, infrastructure

resilience, organizational and human capital capacity, interoperability, and shared digital enablers, as well as cybersecurity, data privacy, and public esteem.

2.3 Institutional Capacity and Fragmentation

The coordination of institutionalizing is a necessary condition for the enterprise-level digital transformation, as most significant public services registering a business, updating one's civil status, administering taxes cut across rather than are neatly located inside one-official agency or layer of government. In the Libyan instance, decentralized supervision has led countless times to redundant IT purchases, divergent technical standards, and siloed database structures within ministries (USAID, 2022; Wynn et al., 2021). With no higher authority to oversee, agencies build digital systems around their own onions which solidify rather dissolve the data silos that isolates them from other agencies.

2.4 Regulatory Readiness and Legal Legitimacy

Digital administration does not run-on hardware and software alone - it must be supported by a legal framework that treats electronically produced records, digital signatures, Eid's and the protection of personal data as legitimate alternatives to paper-based ones. In situations where law remains stuck while technology moves forward, government officials may still be formally obligated to insist on hard copies and wet signatures even as the digital system they have on hand is making some or much of that traditional paperwork obsolete result which voids out much of the efficiency improvement the system was designed to deliver (USAID, 2022). Consequently, the preparedness of the regulator for regulation is to be considered a precondition of infrastructural preparedness and not a matter of downstream compliance to be addressed when systems have already been established.

2.5 Infrastructure Resilience and Spatial Disparities

The digital delivery of government services can be maintained only then if there is reliable electricity, predictable access to telecommunications infrastructure, government data housed in secure facilities, and working disaster-recovery plans. Research on the Libyan state's public bodies has exposed endemic power outages, unstable internet connection, and devices long past the point of receiving vendors' technical supports (Wynn et al., 2021). These unevenness's not only persist but are stark: the disparities in access to connectivity between the urban coastal belt and Libya's southern interior remain wide, making the further expansion of digital services a risk in amplifying, rather than mitigating, existing regional exclusion (USAID, 2022).

2.6 Organizational Competencies and Human Capital

Buying technology is not a substitute for the ability to use it. To transform effectively, the public sector needs specialists in database management, cybersecurity, service design, IT procurement and digital project management-positions often under-resourced or non-existent in weak administrative systems-and for someone to orchestrate the overall transformation. Research has moreover revealed deep skills gaps and a lack of formalized training for executives as enduring challenges to administrative capacity for digital transformation at Libyan local authorities in particular (Forti & Wynn, 2017; Wynn et al., 2021).

2.7 Interoperability, Digital Identity, and Shared Platforms

Interoperability enables different government databases to exchange structured information without manual re-entry or duplicated validation. The "Government as a Platform" principle sees centralized digital identity systems and unified payment mechanisms as shared infrastructure that enables data ownership and prevents repetitive data gathering among agencies and reduces the transaction expenses which citizens and companies have when they interact with government (OECD, 2020). The banking sector in Libya is still fragmented and rival digital wallet providers are hindering the development of comprehensive, end-to-end digital transactions (USAID, 2022).

3. Theoretical Framework

Theoretical model This investigation employs a multi-level theoretical model combining TOE, TAM, and UTAUT with a unifying construct of Digital State Capacity, based on the assumption that a single framework mechanism applied in isolation cannot explain outcomes that are at once institutional, organizational, and individual in nature.

Technology-Organization-Environment (TOE) Framework TOE provides the major macro to meso level analytical framework for this study (Tornatzky & Fleischer, 1990). Its technological component includes questions of infrastructure availability, technical standards, and interoperability; its organizational component includes questions of leadership availability, workforce competence, and resource availability; and its environmental component includes questions of regulatory policies, political stability, and inter-agency relations.

TAM and UTAUT. These models provide explanations at the micro level for the adoption behavior of individuals (Davis, 1989; Venkatesh et al., 2003). Constructs like Perceived Usefulness, Perceived Ease of Use, Performance Expectancy and Facilitating Conditions explain why individual users accept or resist a particular digital service—but this article conceptualizes those variables as end-results themselves modulated by the sufficiency of behind-the-scenes organizational and infrastructural preparedness rather than as independent catalysts for adoption.

4. Methodology

4.1 Design of PRISMA Study Protocol

The review is designed as a narrative documentary analysis and thematic synthesis and was carried out following the PRISMA 2020 statement (Page et al., 2021). Drawing on the analytical and qualitative nature of the research questions, the methodology synthesizes peer-reviewed academic literature, authoritative institutional reports, and international diagnostic norms not as a means of testing a preconceived theory but to develop a contextually situated theoretical frame.

4.2 Search Identification and Strategy

The literature was sought using a systematic search in Scopus, Web of Science, Google Scholar, and the institutional repositories of the United Nations, USAID, and the OECD. The searches used Boolean logic and combined terms within three thematic clusters: a geography cluster (“Libya” OR “Libyan”), a domain cluster (“digital government” OR “e-government” OR “digital transformation”), and a construct cluster (“institutional capacity” OR “TOE” OR “UTAUT” OR “TAM” OR “interoperability”).

4.3 Criteria for Eligibility and Quality Assessment

The inclusion criteria were peer-reviewed empirical studies/case studies, policy reports and diagnostic tools related to the period from 1989-2026 which discussed the model of technology adoption, digital transformation, or public administration reform. Non-commercial whitepapers that were not verified and opinion-based commentary lacking a documented evidence base were excluded from the analysis."

5. Synthesis of Findings

The thematic synthesis reveals six cross-cutting structural factors that shape the trajectory of Libya’s digital transformation. These are juxtaposed in Table 1 with the theoretical dimensions from which they emanate.

Table 1. Structural conditions shaping digital government transformation in Libya

Theoretical Dimension	Key Empirical Findings in Libya	Structural Impact on Digital Transformation	Primary References
Environmental / Legal (TOE)	Regulatory uncertainty; absence of comprehensive digital-signature and data-protection legislation	Restricts the legal validity of electronic transactions; perpetuates reliance on manual paper backups	USAID (2022)
Organizational Governance (TOE)	Institutional fragmentation; no unified lead digital agency; overlapping agency mandates	Produces siloed IT investment, duplicated platforms, and cross-agency data incompatibility	Shwehdy (2025); Wynn et al. (2021)
Technological Infrastructure (TOE)	Unreliable electrical power; intermittent connectivity; pronounced urban-rural disparities	Disrupts continuity of service delivery; erodes user trust in system availability	USAID (2022); Wynn et al. (2021)
Organizational Capacity (TOE)	Acute ICT skill shortages; limited executive change-management capability; heavy reliance on external vendors	Undermines long-term system ownership, maintenance, and administrative adaptability	Forti & Wynn (2017)
Facilitating Conditions (UTAUT)	Fragmented digital payment gateways; no unified national electronic identity system	Prevents complete, end-to-end digitization of services across agency boundaries	OECD (2020); USAID (2022)
Performance Expectancy (TAM/UTAUT)	Notable citizen willingness to adopt, constrained by security concerns, digital-literacy gaps, and system downtime	Limits sustained adoption despite nominal citizen interest in digital services	Davis (1989); Venkatesh et al. (2003)

6. A model that captures the digital state capacity

To find a solution for the structural fragmentation above, I construct a seven-level hierarchical model of digital state capacity in which upper layers of service integration are conceptualized as contingent on the stability of foundational layers of services below (Table 2).

Table 2. Seven-tier architecture of digital state capacity

Tier	Architecture Dimension	Core Components and Operational Focus	Key Structural Dependency
Level 7	Public Value Outcomes	Reduced administrative friction, greater transparency, stronger citizen trust, regional equity	Enabled by Level 6 integration

Level 6	Integrated Services	Fully online civil status, business licensing, tax submission, customs, and municipal services	Requires Level 5 shared enablers
Level 5	Shared Digital Enablers	Unified digital ID, National Interoperability Framework (NIF), G2G data-exchange API gateway, payment gateway	Requires Level 4 infrastructure
Level 4	Digital Foundations	Secure government cloud (G-Cloud), redundant high-speed backbones, backup power, security operations centers	Requires Level 3 organizational readiness
Level 3	Organizational Capacity	Role-specific ICT training, digital leadership programs, standardized procurement, internal technical support	Requires Level 2 regulatory grounding
Level 2	Regulatory Foundations	Enacted legislation on e-signatures, digital transactions, data privacy, cybercrime, and open government data	Requires Level 1 authority
Level 1	Institutional Foundations	A legally empowered National Digital Transformation Authority, central oversight, cross-agency steering committees	Supreme institutional baseline

7. Discussion

Based on this synthesis, three theoretical and policy implications can be derived.

Needless to say, TAM and UTAUT have been originally developed, and are most suited, for individual-level analysis and thus provide useful insights on citizen perceptions and experiences with digital services. A citizen may find the government portal easy to use and really have the perception good things must be behind it, but that citizen absolutely cannot complete a transaction if law requires her to get a paper document stamped in person. The combination of TOE and TAM/UTAUT is what enables the analysis to cross this micro-macro gap, rather than confusing a positive user-experience result with functioning digital government.

Secondly, the DSC framework changes the way international index swings are viewed. Libya's Move in the 2024 UN Survey into the High EGDI group is reflecting real, and positive, improvements in service availability and telecommunications infrastructure (United Nations, 2024). But the framework proposed here indicate that this progress may be read as necessary but not sufficient: sustainable digital government transformation will also depend on bolstering back-office interoperability, regulatory enforcement, and infrastructural resilience—these aspects are not completely recorded by front-end availability-calibrated composite indices (Healy et al., 2026). Third, as much as substance, there is the question of sequencing. Striving to “digitize everything” on the front end without first establishing institutional coordination and prior regulatory clarity, more often than not results, on the evidence reviewed here, in fragile, poorly integrated applications rather than sustainable, government-wide capacity.

8. Theoretical Contributions

- Transformation as state capacity. Toward this end, the study reorients the analytical focus in the digital government literature away from technology adoption and toward structural state capacity as the more fundamental determinant of outcomes, particularly in weak and fragmented institution contexts.

- Theoretical triangulation. It deploys TOE as an environmental and organizational lens to examine and analyze at user level the adoption process of these two traditions.
- Institutionalizing interoperability. It treats shared platforms – digital identity, the NIF, unified payments, etc-as essential public-sector infrastructure rather than mere technical protocol for individual service projects.

9. Phased Policy Roadmap and Evaluation Matrix

Implementing the Digital State Capacity model as a strategic plan involves a phased implementation roadmap coupled with quantifiable performance metrics.

Phase 1 - Institutional and Legal Foundations (Months 1-12): Create a legally empowered central digital transformation authority; pass laws on e-signatures, data security, and cybercrime; create a NIF.

Phase 2 - Shared Infrastructure and Organizational Readiness (Months 13-24): Establish secure government data centers; secure energy back-up and disaster recovery plans; introduce a national digital identity system and unified payment gateways; initiate capacity building programs within ministries.

Phase 3 - Impactful Integrated Service Delivery (Months 25-48): Redesign core cross-agency services (civil status, business registration, tax administration, customs clearance) and mandate API integration across partners to enforce it.

Phase 4 - Inclusion, Evaluation, and Governance Optimization (Ongoing): Establish assisted digital-service channels for remote regions; continuously monitor system uptime and security posture; publish open performance dashboards for public accountability.

Table 3: Evaluation Matrix for the Phased Roadmap

Dimension	Key Performance Indicator	Measurement Methodology	Target Benchmark
Governance	Cross-agency compliance with the National Interoperability Framework	Annual audit of agency API adoption	100% of core ministries integrated
Infrastructure	Government cloud (G-Cloud) uptime and redundant system availability	Automated continuous log monitoring	99.9% operational availability
Regulation	Legal acceptance rate of digital signatures and electronic records	Judicial and administrative review audits	Zero mandatory paper fallback for digital-ID users
Service Adoption	Share of public transactions completed digitally end-to-end	National transaction portal telemetry	Above 60% adoption within three years of rollout
Inclusion	Digital service completion rates in non-coastal and rural regions	Spatial analytics of user transaction logs	Equitable completion rates across all regions

10. Limits and Future Directions

This research draws on a systematic review and qualitative synthesis of secondary sources, including empirical work and reports from institutions; it does not involve first-order statistical validation among populations of Libyan citizens, and the propositions of the framework should thus be considered as theoretically derived rather than empirically substantiated. Subsequent studies may need to enhance the evidence base by conducting national-level quantitative

surveys of citizens and users of the public sector; by comparative case research at the level of Libyan municipalities, in which contrasts/variations in institutional capacity will likely be detectable; and, by means of running structural equation modeling (SEM) to validate the set of relationships among the seven dimensions of digital state capacity elaborated in this study.

11. Conclusion

Digital government transformation in fragile and institutionally fragmented environments is not an issue that can be addressed simply by acquiring technology. This requires ‘digital state capacity’-the state’s combined institutional, legal, infrastructural, and organizational capacity to govern and sustain digital ecosystems over time, not to simply launch discrete digital projects. In short, through the factors of overcoming fragmentation, creating regulatory certainty, making resilient infrastructure, and using shared digital platforms at the abovementioned progressive levels, Libya has a real prospect at evolving from splintered digital activities into quintessential, secure, and resilient digital state system.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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