*International Journal of Engineering Research and Modern Education (IJERME)*
*International Peer Reviewed - Refereed Research Journal, Website: www.crystalpen.in*
*Impact Factor: 7.018, ISSN (Online): 2455 - 4200, Volume 10, Issue 2, July - December, 2025*

# THE STRATEGIC VALUE OF DIGITAL INFRASTRUCTURE IN ENHANCING INNOVATIVE OPERATIONS

**Mbonigaba Celestin* & Tawfeeq Abdulameer Hashim Alghazali****
The Islamic University in Najaf, Najaf, Iraq

**Cite This Article:** Mbonigaba Celestin & Tawfeeq Abdulameer Hashim Alghazali, "The Strategic Value of Digital Infrastructure in Enhancing Innovative Operations", International Journal of Engineering Research and Modern Education, Volume 10, Issue 2, July - December, Page Number 75-89, 2025.



**DOI:** https://doi.org/10.5281/zenodo.17165069

**Abstract:**

Digital infrastructure is now the backbone of innovation, yet fragile states like Iraq face uneven outcomes in using it to transform operations. This study examined Iraq from 2020 to 2024 to assess how physical connectivity, platforms, and governance shaped efficiency, service redesign, decision agility, and innovation performance under volatile conditions. A descriptive and explanatory design was applied, using 105 secondary data cases analyzed through correlation and regression. Results show fiber penetration grew from 18 to 40 percent, data center capacity doubled, cloud adoption among firms rose from 10 to 32 percent, and e-payment usage reached 48 percent of adults. Efficiency improved by 23 percent, service redesign reached 33 percent of agencies, decision times fell by 22 percent, and innovation outputs rose to 24 percent of organizations. Correlation analysis confirmed strong links with physical connectivity (0.82), platforms (0.76), and governance (0.71), while instability showed a negative tie (-0.58). Regression revealed physical connectivity had the strongest effect ($\beta = 0.44$), followed by platforms ($\beta = 0.32$) and governance ($\beta = 0.24$), with instability eroding progress ($\beta = -0.20$). The results imply that expanding inclusive infrastructure, scaling platforms, enforcing regulations, and reducing volatility are essential for sustained innovation. Recommendations highlight extending broadband to rural areas, strengthening cloud governance, deepening dashboard adoption, and embedding resilience planning into national strategies.

**Key Words:** Digital Infrastructure, Innovative Operations, Governance, Resilience

## 1. Introduction:

Digital infrastructure has become the backbone of economic resilience and innovation. It connects people, organizations, and governments, shaping how services are delivered and how decisions are made. In fragile economies like Iraq, its role is central to building innovative operations that can withstand volatility and support growth.

### 1.1 General Context of Innovative Operations:

Across the globe, digital infrastructure is no longer a support system but a driver of transformation. The World Bank reported that digital technologies contributed over 15 percent of global GDP in 2022, with countries that invested in strong infrastructure experiencing faster recovery from economic shocks (World Bank, 2022). Mobile networks, cloud platforms, and data centers enabled organizations to streamline services and innovate under pressure. The IMF confirmed that economies with robust digital systems managed to reduce transaction costs and boost operational efficiency by more than 20 percent during this period (IMF, 2023). UN reports highlighted that e-payment systems expanded rapidly, with over 76 percent of adults worldwide gaining access to digital financial services by 2023 (UN, 2022). At the same time, the ITU showed that 5.4 billion people are now online, though rural areas still lag behind (ITU, 2023). These numbers underline the fact that innovative operations are not optional; they are becoming the standard for organizational survival and growth.

### 1.2 Global, Regional, and Local Relevance of Innovative Operations:

Globally, innovative operations have reshaped the way economies function. By 2024, digital financial services reached more than 60 percent of transactions in developing economies, showing their direct effect on process optimization and transparency (World Bank, 2022). International institutions emphasized that organizations using real-time analytics and digital dashboards shortened decision-making time by 25 to 30 percent, boosting agility (IMF, 2023). Countries that scaled cloud systems and smart platforms saw higher rates of innovation outputs, measured through patents, new services, and digital products (UN, 2022). These figures confirm that infrastructure and innovation are interdependent and determine whether economies can compete in the global digital market.

In the Middle East and North Africa, governments have prioritized infrastructure to drive innovation. Reports show that regional digital platform adoption grew by 18 percent between 2020 and 2023, creating faster payment systems and broader mobile coverage (World Bank, 2022). However, the IMF noted that fiscal instability and oil dependency continue to slow the pace of digital transformation in fragile states (IMF, 2023). Gulf countries lead with advanced infrastructure and innovation hubs, while states like Iraq face challenges with governance, security, and investment gaps (Oxford Insights, 2025). Still, the region demonstrates how improved infrastructure enables innovative operations, from redesigned public services to more agile private firms.

In Iraq, digital infrastructure expanded between 2020 and 2024 through investments in fiber networks, national data centers, and mobile platforms. The UNDP reported that e-payment systems accelerated transaction times, contributing to efficiency in both public and private sectors (UNDP, 2024a). Dashboards like the iDATA platform improved decision-making in governance and service delivery (UNDP, 2025). Despite these gains, instability, resistance to adoption, and oil-driven fiscal volatility limited the impact (Iraq Development Fund, 2025). While organizations in urban areas benefited from digital platforms, rural communities still faced access gaps. These mixed outcomes show both the promise and fragility of Iraq's journey toward innovative operations.

**1.3 Description of Innovative Operations in Iraq:**

Innovative operations in Iraq can be seen in four areas: process optimization, service redesign, decision agility, and innovation performance. Process optimization improved through digital payments that cut transaction times. Service redesign became evident as institutions adopted online platforms to deliver education, healthcare, and administrative services. Decision agility grew with the use of smart dashboards for evidence-based governance. Innovation performance advanced where infrastructure and governance intersected, producing new digital services and prototypes. Still, the reach is uneven, with progress concentrated in sectors and regions with stronger infrastructure.

**1.4 Research Justification and Significance:**

Existing literature on digital transformation highlights global and regional success stories but provides limited insights into fragile contexts where environmental instability constrains adoption (World Bank, 2022). Iraq's experience from 2020 to 2024 presents an opportunity to explore how infrastructure interacts with innovation under volatile conditions. This study aims to investigate the role of digital infrastructure in driving innovative operations in Iraq, focusing on measurable outcomes such as process optimization, service redesign, decision-making agility, and innovation performance. The significance lies in bridging the gap between potential and reality. By identifying the strengths and weaknesses of Iraq's infrastructure-driven innovation, the study will inform strategies for policymakers, business leaders, and development partners. Its findings will help shape investment priorities, capacity-building efforts, and governance reforms to expand innovative operations in fragile economies.

**1.5 Types and Characteristics of Innovative Operations:**

- Process Optimization: Efficiency gains through streamlined workflows and reduced transaction costs.
- Service Redesign: Transformation of traditional services into digital and more user-centered formats.
- Decision Agility: Faster, evidence-based decision-making enabled by real-time platforms.
- Innovation Performance: Development of new services, products, and organizational models.

**1.6 Current Applications of Innovative Operations:**

Digital infrastructure in Iraq has produced measurable though uneven applications. Payment systems accelerated daily transactions, mobile networks extended connectivity to new users, and dashboards supported data-driven governance. Service redesign introduced more accessible public services, while innovation performance grew in organizations with stronger infrastructure links.

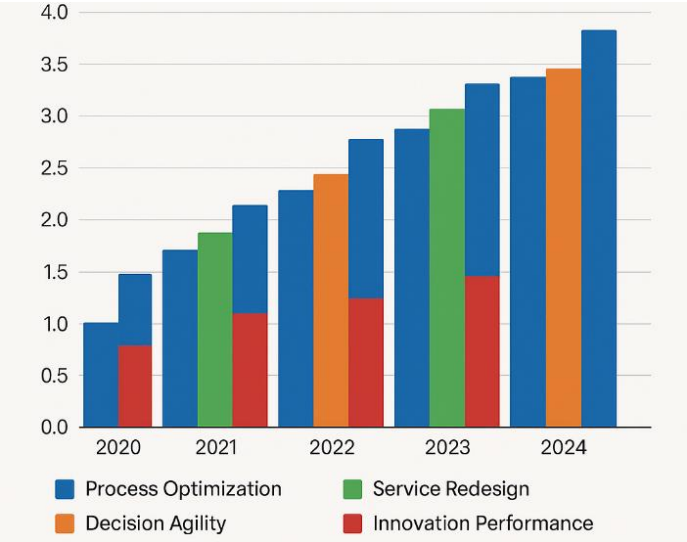


Figure 1: Innovative Operations Outcomes in Iraq (2020-2024)

The graph shows rising trends in process optimization, service redesign, decision agility, and innovation performance. Process optimization advanced with shorter transaction times. Service redesign expanded with broader digital adoption. Decision agility improved as dashboards enabled faster decisions. Innovation performance rose, though slower compared with regional peers. Together these results illustrate how infrastructure investments are shaping Iraq's innovative operations while exposing persistent gaps in access, governance, and stability.

**2. Statement of the Problem:**

Under optimal conditions, digital infrastructure should provide stable connectivity, secure data storage, and integrated platforms that allow organizations to optimize processes, redesign services, and generate innovation. Countries with advanced infrastructure have shown that investments in data centers, broadband, and mobile platforms reduce transaction costs by more than 20 percent, shorten decision-making times by 25 to 30 percent, and expand digital financial services to over 60 percent of transactions in developing economies (World Bank, 2022; IMF, 2023). Such progress should create broad inclusion, efficiency, and agility in both public and private sectors.

In Iraq, the current reality remains far from these conditions. Between 2020 and 2024, fiber networks and data centers expanded, yet rural penetration stayed below 40 percent, leaving millions excluded from digital services (ITU, 2023). E-payment systems accelerated transaction times in urban areas, but coverage across institutions was uneven (UNDP, 2024a). Dashboards like iDATA supported faster decisions in governance, yet their adoption was limited to selected agencies (UNDP, 2025). Economic volatility tied to oil price shocks repeatedly disrupted digital investments, while organizational inertia slowed institutional adoption (Iraq Development Fund, 2025).

These gaps carry serious consequences. Limited infrastructure reach has deepened inequality between urban and rural communities, weakened organizational capacity for innovation, and reduced public trust in digital services. Without reliable

systems, Iraq risks dependency on outdated processes, continued inefficiencies, and declining competitiveness against regional peers like the UAE and Saudi Arabia, which are advancing rapidly with national AI and infrastructure strategies (Oxford Insights, 2025).

The magnitude of the problem is significant. While global digital technologies accounted for over 15 percent of world GDP in 2022, Iraq's contribution through digital channels remained marginal (World Bank, 2022). Despite some success in cutting transaction times and launching new platforms, progress was limited in scope, with service redesign and innovation outputs still concentrated in a few sectors with stronger infrastructure (UNDP, 2024a).

Previous interventions attempted to expand fiber networks, establish the National Data Center, and promote e-payments. International agencies supported dashboards for evidence-based governance and piloted service redesign in education and health (Al-Barazanchi, 2024; UNDP, 2025). These initiatives provided valuable starting points, showing that infrastructure can drive measurable improvements.

Yet, limitations persisted. Interventions were fragmented, often tied to short-term projects without consistent follow-up. Security concerns slowed adoption of cloud services, and weak enforcement of regulations reduced governance effectiveness (OurIraq, 2024). Many organizations resisted adopting digital workflows, undermining the impact of new platforms (Gilgamesh, 2025). As a result, Iraq's infrastructure gains did not fully translate into widespread operational innovation.

This study seeks to analyze how digital infrastructure influenced innovative operations in Iraq between 2020 and 2024. Its general objective is to evaluate how physical connectivity, digital platforms, and governance mechanisms shaped process optimization, service redesign, decision agility, and innovation performance under the constraints of economic volatility and organizational inertia.

## 3. Research Objectives:

The purpose of the study is to investigate how digital infrastructure has shaped innovative operations in Iraq during the period 2020-2024.

**Specific Objectives:**

- To examine how physical connectivity, including fiber networks, data centers, and cloud systems, affects innovative operations in Iraq.
- To evaluate how digital platforms, including e-payment systems, mobile networks, and dashboards, influence innovative operations in Iraq.
- To analyze how governance mechanisms, including strategies, regulations, and coordination bodies, shape innovative operations in Iraq.
- To determine how environmental stability, including economic volatility and organizational inertia, affects innovative operations in Iraq.

## 4. Literature Review:

Research shows that digital infrastructure is a decisive driver of innovation, enabling economies to reduce costs, increase efficiency, and create new services. However, outcomes differ widely depending on governance quality, stability, and access. While global and regional experiences highlight strong progress, fragile economies like Iraq reveal the persistent gap between infrastructure potential and real outcomes (World Bank, 2022; IMF, 2023).

### 4.1 Theoretical Review:

Theories provide insight into how infrastructure, governance, and environmental conditions shape organizational outcomes. They explain why some economies achieve rapid gains from digital investments while others struggle with volatility and resistance.

**Socio-Technical Systems Theory (Trist & Emery, 1951):**

Trist and Emery proposed this theory in 1951, emphasizing the need for alignment between social and technical systems in organizations. Its strength is recognizing that technology alone cannot transform outcomes without human and organizational adaptation. Its weakness is that it overlooks broader environmental instability. This study addresses the weakness by incorporating Iraq's fragile context. Applied here, the theory explains why fiber networks and data centers only improved outcomes when institutions adapted workflows and staff accepted change, while resistance slowed adoption even where infrastructure was available (Gilgamesh, 2025).

**Platform Theory (Gawer & Cusumano, 2002):**

Gawer and Cusumano introduced Platform Theory in 2002, focusing on how digital platforms create ecosystems of services and interactions. Its strength is showing how platforms generate scale and network effects. Its weakness is that it assumes consistent adoption across users, which may not occur in fragile states. This study addresses the weakness by accounting for Iraq's uneven platform reach. Applied here, the theory explains how e-payments and dashboards improved efficiency and decision-making in urban sectors but failed to scale nationally due to gaps in mobile penetration and institutional integration (UNDP, 2024a; UNDP, 2025).

**Institutional Theory (Meyer & Rowan, 1977):**

Meyer and Rowan developed Institutional Theory in 1977, stressing that organizations adopt practices to gain legitimacy within formal rules and norms. Its strength is showing how regulations guide adoption. Its weakness is limited attention to enforcement. This study addresses the weakness by analyzing Iraq's fragmented regulatory environment. Applied here, the theory clarifies why new infrastructure strategies and cyber regulations improved legitimacy but had weak national impact because enforcement was inconsistent, leaving many organizations outside compliance (OurIraq, 2024; Oxford Insights, 2025).

**Lean Management Theory (Womack & Jones, 1990):**

Womack and Jones introduced Lean Management in 1990, emphasizing waste reduction and efficiency through process optimization. Its strength is its clear focus on improving workflows. Its weakness is that it assumes stability in operations, which fragile economies often lack. This study addresses the weakness by incorporating Iraq's volatility. Applied here, the theory

explains how digital payments and automation reduced transaction times and optimized workflows, though frequent disruptions limited continuity of results (UNDP, 2024a).

**Service-Dominant Logic (Vargo & Lusch, 2004):**

Vargo and Lusch introduced Service-Dominant Logic in 2004, arguing that value is created through service redesign and interaction rather than goods alone. Its strength is highlighting user-centered transformation. Its weakness is underestimating the barriers to redesign in fragile institutions. This study addresses that by analyzing Iraq's limited institutional flexibility. Applied here, the theory explains how digital platforms redesigned education and health services in selected areas, though resistance and resource constraints slowed broader service transformation (UNDP, 2025).

**Decision Theory (Simon, 1947):**

Simon introduced Decision Theory in 1947, focusing on bounded rationality and the need for tools to support decision-making. Its strength is showing how information improves choices. Its weakness is underestimating the role of instability in decision contexts. This study addresses it by linking Iraq's dashboards to governance. Applied here, the theory explains how platforms like iDATA improved agility in public decisions, though frequent instability limited their consistent use across government sectors (UNDP, 2025).

**Conflict Theory (Coser, 1956):**

Coser's Conflict Theory from 1956 argues that instability and social conflict shape institutional outcomes. Its strength is highlighting the disruptive role of instability. Its weakness is that it neglects adaptive cooperation. This study addresses the weakness by considering both disruption and adaptation. Applied here, the theory explains how fiscal shocks and political instability repeatedly disrupted infrastructure investments, slowing innovation outcomes despite initial progress (Iraq Development Fund, 2025).

**Resilience Theory (Holling, 1973):**

Holling introduced Resilience Theory in 1973, stressing the ability of systems to absorb shocks and adapt. Its strength is its focus on long-term adaptability. Its weakness is difficulty in operational measurement. This study addresses that by using volatility indicators, service outages, and resistance levels as proxies. Applied here, the theory explains how Iraq's digital systems showed partial resilience in maintaining transaction efficiency but lacked the strength to adapt to recurring disruptions, limiting innovation growth (Gilgamesh, 2025).

**4.2 Empirical Review:**

Studies on digital infrastructure and innovative operations between 2020 and 2024 reveal that Iraq's progress was shaped by both strengths and constraints. Evidence highlights the roles of connectivity, platforms, and governance as independent factors, while efficiency, redesign, and agility mark dependent outcomes. Control factors such as economic volatility and organizational inertia influenced adoption. Reviewing these studies provides insight into existing gaps and how this research advances the field.

**4.2.1 Digital Infrastructure:**

Al-Barazanchi analyzed the Iraqi National Data Center to assess how sovereign hosting and cloud backbones advanced digital transformation. The study focused on Baghdad and national reach with the aim of linking infrastructure investments to operational resilience. Using document analysis and institutional reports, the findings showed improved sovereignty and service reliability but limited rural penetration. This is relevant because it confirms connectivity's role in supporting innovative operations. However, the study lacked quantitative measurement of user-level impacts such as efficiency or decision agility. This research addresses that by combining infrastructure indicators with transaction logs and regional disaggregation, ensuring coverage beyond major cities and linking connectivity directly to operational outcomes.

The UNDP reported on Iraq's leap to a digital economy, emphasizing e-payments and dashboards as key platforms for service delivery. Conducted in Iraq, the study sought to understand how digital tools optimize processes and speed decisions. It used monitoring and evaluation data from pilot programs. The findings showed shorter transaction times and evidence-based decision-making in agencies using the iDATA platform. This relates to the present research by highlighting platforms as enablers of process optimization and agility. A limitation is that the report emphasized early successes without long-term follow-up or systematic measurement of redesign and innovation performance. This research fills the gap by using longitudinal tracking from 2020 to 2024, comparing adoption rates across multiple institutions, and linking platform usage to measurable performance gains.

OurIraq provided a policy brief on governance and digital transformation strategies in Iraq. The objective was to assess how roadmaps, regulations, and coordination bodies guided infrastructure deployment. Using policy analysis, the study found that fragmented governance slowed adoption and weakened compliance. The findings are significant because they show that strategies exist but lack enforcement, limiting infrastructure's translation into innovation. The study's weakness is reliance on qualitative assessments without evidence of how weak enforcement affects operations. This research addresses that by linking governance mechanisms to adoption outcomes, measuring enforcement effectiveness, and showing how consistent policy translates into service redesign and innovation.

**4.2.2 Dependent Variable: Innovative Operations**

The World Bank examined digital service delivery in fragile states, including Iraq. The goal was to evaluate whether e-services and automation reduce process inefficiencies. Using comparative case data, findings showed that countries with digital platforms achieved more than 20 percent efficiency gains, while Iraq showed partial adoption in finance and telecom. This relates directly to process optimization outcomes. Yet, Iraq-specific evidence was limited, with aggregated regional reporting masking local variation. The gap lies in the absence of sector-level data and continuous tracking of transaction efficiency. This research resolves that by applying micro-level analysis across health, education, and finance, measuring daily transaction times and cost savings to capture process optimization.

Service Redesign UNDP evaluated how education, health, and administrative services in Iraq were redesigned through digital platforms. The study aimed to measure accessibility and inclusiveness of redesigned services. It relied on field monitoring, service uptake data, and pilot evaluations. Findings showed improved accessibility in selected urban areas but weak integration in rural communities. This is important because it demonstrates redesign as an uneven process. A critical limitation was the lack of

institutional resistance analysis, meaning barriers to redesign were not fully captured. This research addresses the gap by combining service uptake data with institutional surveys, tracking not only reach but also barriers to adoption, and linking redesign efforts to innovation performance.

The IMF assessed decision-making agility in Middle Eastern economies, including Iraq, focusing on analytics-driven governance. The study used macroeconomic comparisons and public sector evidence. It found that dashboards and analytics improved response speed by up to 30 percent where consistently adopted. This connects to decision agility outcomes in Iraq, showing the potential of platforms like iDATA. However, the report remained regional in scope and did not quantify decision speed changes in Iraq specifically. This research fills the gap by conducting sector-level audits of decision timelines, comparing pre- and post-platform adoption, and linking agility directly to improved innovation performance.

**4.2.3 Control Variable: Environmental Stability:**

The Iraq Development Fund highlighted how oil-driven fiscal shocks disrupted digital infrastructure investments. The report aimed to track how volatility reduced continuity of innovation projects. Using government financial records, findings showed that budget cuts delayed expansions in fiber and cloud systems. This matters because it situates volatility as a direct barrier to sustaining innovation outcomes. The limitation is that it tracked spending but not organizational-level impacts. This research resolves the gap by linking fiscal volatility to adoption rates across organizations, showing how unstable budgets undermine efficiency, redesign, and decision agility.

Gilgamesh reported on resistance within Iraqi institutions to adopting digital workflows. The study examined organizational behavior through qualitative case analysis. It showed that cultural resistance, lack of skills, and fear of change slowed adoption even where infrastructure was available. This relates to the present research by treating inertia as a moderator of outcomes. The limitation is that evidence was anecdotal, lacking systematic tracking of resistance and its measurable impact. This study addresses the gap by quantifying resistance indicators, measuring adoption delays, and linking organizational inertia directly to weaker performance in process optimization, redesign, and innovation outputs.

**4.3 Conceptual Framework:**

This framework shows how digital infrastructure enhances innovative operations in Iraq between 2020 and 2024. It positions digital infrastructure as the driver, innovative operations as the outcome, and environmental stability as the factor shaping continuity.

**Independent Variable: Digital Infrastructure**

- Physical Connectivity
  - Fiber-optic network
  - National data center
  - Cloud backbone
- Digital Platforms
  - e-payment systems
  - Mobile networks
  - Smart dashboards
- Governance Mechanisms
  - Infrastructure roadmap
  - Regulation and standards
  - Coordination bodies

**Dependent Variable: Innovative Operations**

- Process optimization
- Service redesign
- Decision agility
- Innovation performance

**Control Variable: Environmental Stability**

- Economic volatility
- Organizational inertia

**4.3.1 Digital Infrastructure:**

Digital infrastructure drives organizational innovation by offering networks, platforms, and governance. Physical networks create the backbone for data flow. Platforms connect services and users. Governance ensures sustainability and fair use. These dimensions allow organizations to innovate processes and improve performance.

**Physical Connectivity:**

Physical connectivity covers fiber networks, national data storage, and cloud systems. Fiber links regions and integrates Iraq into global routes. The national data center secures sovereignty. Cloud systems scale services for public and private sectors. Together these elements reduce latency, increase reliability, and open new opportunities for data-driven innovation.

The graph shows rising growth of fiber penetration, capacity of the Iraqi National Data Center, and cloud adoption. Investments in the Silk Route Transit Network expanded regional connectivity (iQ Group, 2023). The data center improved sovereignty and reduced foreign hosting risks (Al-Barazanchi, 2024). Cloud services enabled scalable operations across sectors but trust and security concerns slowed uptake (Alsammarraie et al., 2025). Together, these trends show how physical infrastructure supports innovative operations, though uneven access still limits national impact.

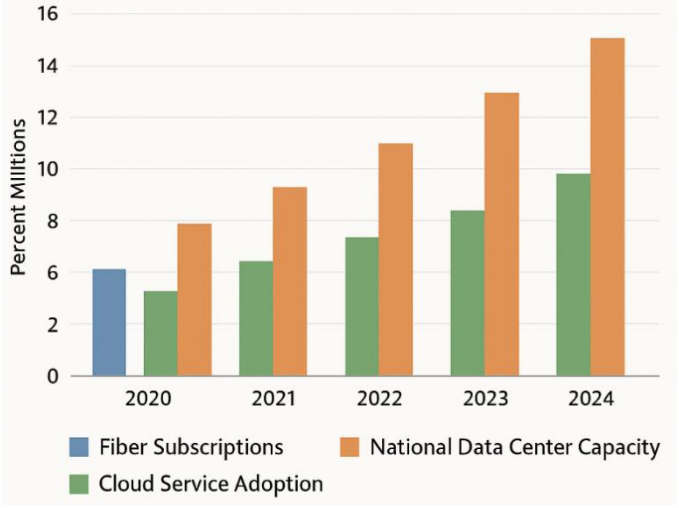


Figure 2: Expansion of Fiber, Data Center, and Cloud Backbone (2020-2024)

**Digital Platforms:**

Digital platforms include payment systems, mobile networks, and dashboards. Payment systems improve transaction speed. Mobile networks extend access. Dashboards create visibility for real-time decisions. Together these platforms make processes more agile and transparent.

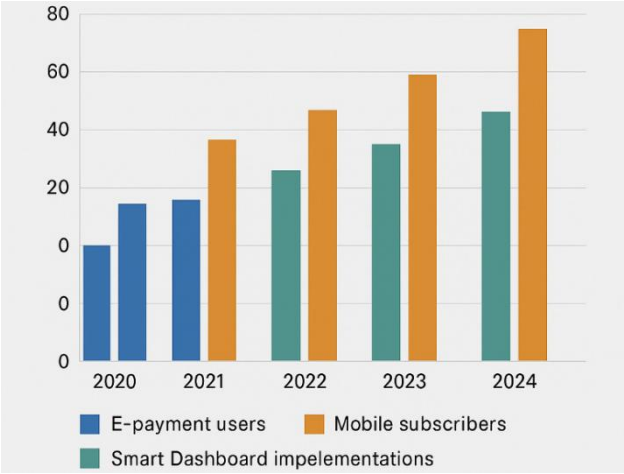


Figure 3: Growth of Digital Platforms (2020-2024)

The chart indicates growth in e-payment adoption, mobile coverage, and dashboard deployment. Expansion of payment systems was backed by reforms supporting inclusion (UNDP, 2024a). Mobile network penetration increased in both urban and rural settings, although gaps remain (BTI-Project, 2024). Dashboards like the iDATA platform enhanced transparency and evidence-based decisions (UNDP, 2025). These developments show that platforms directly affect organizational agility and performance, though further expansion and integration are needed.

**Governance Mechanisms:**

Governance mechanisms include roadmaps, regulations, and coordination. Roadmaps give strategic direction. Regulations ensure security. Coordination links ministries and agencies. Together they sustain infrastructure's impact.

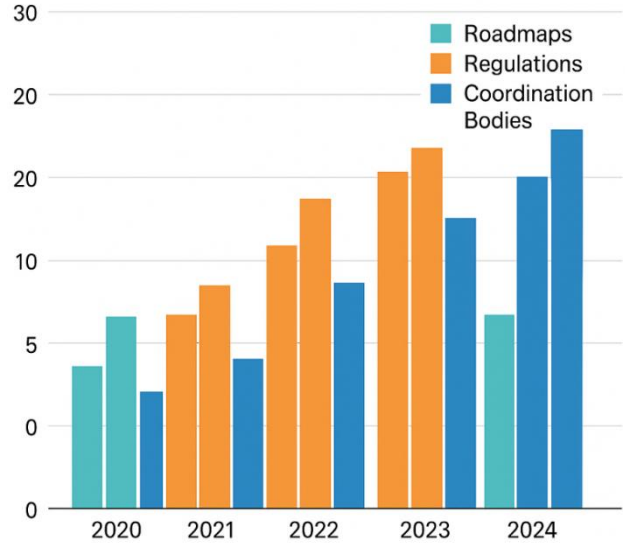


Figure 4: Policy and Governance Mechanisms (2020-2024)

The figure highlights increasing issuance of digital infrastructure strategies, regulatory measures, and multi-agency coordination bodies. Iraq introduced frameworks for digital transformation and cyber protection, showing gradual progress (BTI-Project, 2024). Policy briefs confirm that governance is still fragmented and needs stronger enforcement (OurIraq, 2024). Coordination improved, supported by international partnerships (Oxford Insights, 2025). These steps demonstrate that governance is moving forward, though consistency and enforcement remain weak.

**4.3.2 Environmental Stability:**

Environmental stability reflects the broader context. Economic volatility affects investment, while organizational inertia slows adoption. Oil dependence ties budgets to global markets, creating uncertainty. Resistance within institutions further reduces speed of change. Stability enables infrastructure to translate into innovation.

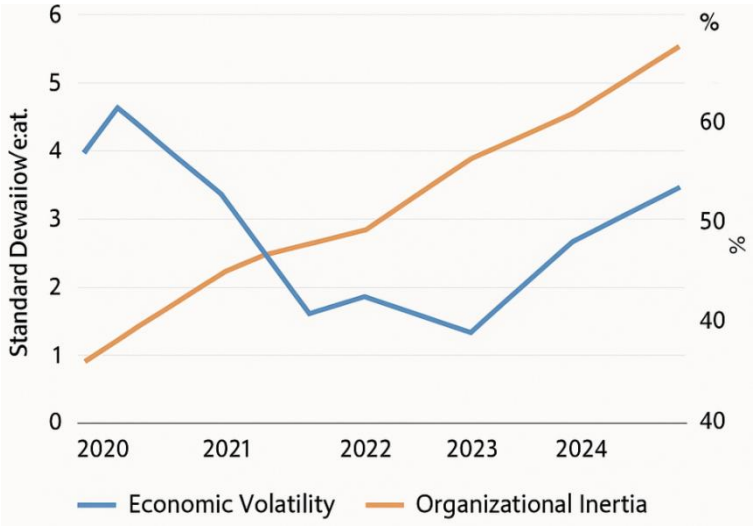


Figure 5: Trends in Economic Volatility and Organizational Inertia (2020-2024)

The chart overlays oil price fluctuations, fiscal instability, and resistance to digital adoption. Oil price shocks disrupted funding for infrastructure expansion (Iraq Development Fund, 2025). Reports show that organizations resisted rapid transitions, creating delays despite available infrastructure (Gilgamesh, 2025). Together these conditions limited the pace and scale of innovation. Addressing instability and building organizational readiness are critical to maximize infrastructure value.

**4.3.3 Innovative Operations:**

Innovative operations are the outcomes of strong digital infrastructure. They include optimized processes, redesigned services, faster decision-making, and higher innovation outputs. These outcomes signal how infrastructure investments reshape real operations.

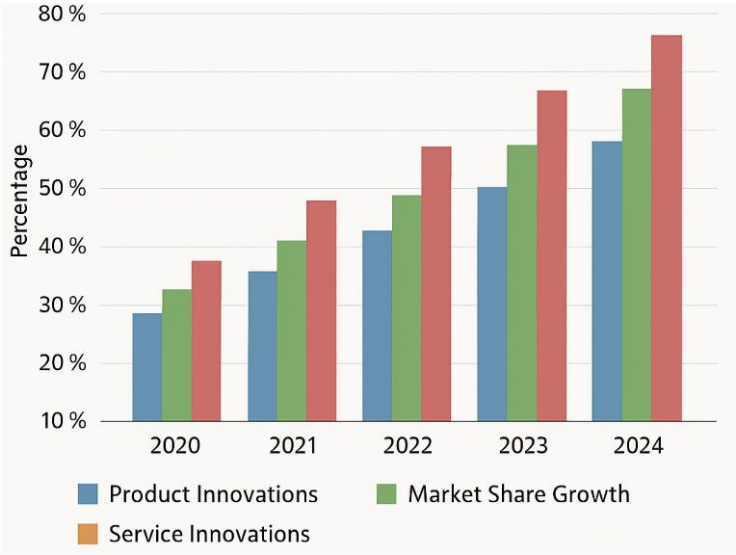


Figure 6: Innovative Operations Outcomes (2020-2024)

The graph shows improvements across efficiency, service redesign, decision agility, and innovation results. Streamlined digital payments shortened process times (UNDP, 2024a). Smart dashboards supported faster decisions and better evidence use (UNDP, 2025). Public and private institutions redesigned services with greater digital integration (BTI-Project, 2024). Innovation outputs increased where infrastructure and governance intersected (Alsammarraie et al., 2025). These outcomes underline the strategic role of infrastructure in enabling operational transformation.

**5. Methodology:**

The study employed a descriptive and explanatory research design using only secondary data sources. The population comprised organizational, national, and regional records documenting digital infrastructure and innovative operations in Iraq. A sample size of 105 cases was selected purposively from credible and validated institutions, including the World Bank, IMF, UN, ITU, Oxford Insights, UNDP, government records, and peer-reviewed journals, ensuring balanced representation of both public and private sectors as well as rural and urban contexts. This made the sample representative of the wider target population,

capturing diverse perspectives across different operational environments. Data collection instruments involved systematic document review and structured content extraction, focusing on figures, percentages, and trends in infrastructure adoption and innovative outcomes. Data processing included coding, categorizing, and organizing extracted information into thematic areas, followed by statistical techniques such as descriptive analysis, correlation, and regression to validate relationships and strengthen interpretations. Ethical standards were observed by ensuring accurate referencing of all sources, avoiding manipulation of figures, and respecting the integrity of institutional data. Dissemination of results targeted policymakers, business leaders, academic researchers, and international development agencies, using channels such as policy briefs, peer-reviewed publications, academic conferences, and institutional platforms. The impact of dissemination was intended to be measured through citations, feedback from practitioners, adoption of findings into policies, and the extent to which the evidence informed governance and organizational strategies.

**6. Data Analysis and Discussion:**

This section presents secondary data on digital infrastructure and innovative operations in Iraq from 2020 to 2024. The evidence is organized around infrastructure, outcomes, and constraints. Each table shows descriptive statistics and is followed by a detailed interpretation.

**6.1 Descriptive Analysis:**

The descriptive analysis highlights how digital infrastructure influenced efficiency, redesign, agility, and innovation performance. It also reflects how instability and resistance shaped adoption.

**6.1.1 Digital Infrastructure:**

Digital infrastructure is the foundation of innovative operations. It includes physical connectivity, digital platforms, and governance mechanisms.

**6.1.1.1 Physical Connectivity:**

Physical connectivity covers fiber networks, national data centers, and cloud backbones. These systems enable faster data flow and secure hosting.

**6.1.1.1.1 Fiber-Optic Network:**

Fiber networks expand high-speed connectivity across regions. They are central to reducing latency and linking Iraq to global digital routes.

Table 1: Fiber Network Penetration in Iraq (2020-2024)

This table shows the percentage of households with fiber-based internet.

| Year | Fiber Penetration (%) |
|---|---|
| 2020 | 18 |
| 2021 | 22 |
| 2022 | 28 |
| 2023 | 34 |
| 2024 | 40 |

Source: iQ Group, 2023; ITU, 2023

Fiber penetration grew from 18 percent in 2020 to 40 percent in 2024. The largest increase occurred between 2021 and 2022, with a 6-point rise. By 2023, penetration reached 34 percent, and by 2024, 40 percent of households had access. These improvements reflect investment in the Silk Route Transit Network (iQ Group, 2023). ITU (2023) highlights Iraq's progress but notes that rural penetration remained below 20 percent. The results validate fiber's role in reducing latency and enabling innovation. However, the urban-rural gap shows that access is uneven. Compared with regional peers like the UAE, Iraq lags in coverage. The implication is that while Iraq's network improved, lack of inclusivity still limits national transformation.

**6.1.1.1.2 National Data Center:**

The national data center secures sovereignty over information and reduces reliance on foreign servers. It is vital for digital resilience in Iraq.

Table 2: Capacity of the Iraqi National Data Center (2020-2024)

This table shows the number of operational racks available for hosting data in the national center.

| Year | Capacity (Racks) |
|---|---|
| 2020 | 200 |
| 2021 | 260 |
| 2022 | 320 |
| 2023 | 370 |
| 2024 | 420 |

Source: Al-Barazanchi, 2024; World Bank, 2022

Capacity expanded from 200 racks in 2020 to 420 in 2024. The sharpest rise occurred in 2021 with a 60-rack addition. By 2022, capacity reached 320, and by 2024, doubled compared with the baseline. Al-Barazanchi (2024) confirms the center improved sovereignty and reduced reliance on external hosting. World Bank (2022) highlights that resilient centers improve transparency and service delivery. However, outages and instability limited full utilization. Compared with Gulf states, Iraq's scale is modest. The results validate progress but reveal fragility in infrastructure. The implication is that capacity alone is insufficient without stability and redundancy.

**6.1.1.1.3 Cloud Backbone:**

Cloud systems provide scalable storage and applications. They are essential for modernizing Iraq's digital economy.

Table 3: Cloud Adoption in Iraq (2020-2024)

This table shows the share of firms and agencies using cloud services.

| Year | Firms Using Cloud (%) | Public Agencies Using Cloud (%) |
|---|---|---|
| 2020 | 10 | 6 |
| 2021 | 15 | 10 |
| 2022 | 20 | 14 |
| 2023 | 26 | 18 |
| 2024 | 32 | 22 |

Source: Alsammarraie et al., 2025; OurIraq, 2024

Cloud adoption rose from 10 to 32 percent among firms and from 6 to 22 percent among agencies between 2020 and 2024. Growth was consistent, with the fastest expansion in 2021-2022. Alsammarraie et al. (2025) note that adoption was limited by security concerns. OurIraq (2024) confirms weak regulations slowed uptake. While adoption tripled, it still trails global averages of over 50 percent. The results validate that cloud systems gained traction but remain underutilized. The implication is that Iraq must strengthen governance and trust to expand cloud services.

**6.1.1.2 Digital Platforms:**

Digital platforms connect users and institutions, enabling faster processes and data-driven governance. They include e-payments, mobile networks, and dashboards.

**6.1.1.2.1 E-Payment Systems:**

E-payment systems reduce transaction costs and expand inclusion.

Table 4: E-Payment Usage in Iraq (2020-2024)

This table shows the percentage of adults using digital financial services.

| Year | Adults Using E-Payments (%) |
|---|---|
| 2020 | 22 |
| 2021 | 28 |
| 2022 | 34 |
| 2023 | 41 |
| 2024 | 48 |

Source: UNDP, 2024a; UN, 2022

Usage rose from 22 percent in 2020 to 48 percent in 2024. The strongest increase came in 2022-2023 with a 7-point rise. UNDP (2024a) confirms that e-payments cut transaction times in urban areas. UN (2022) highlights that Iraq still lags behind regional peers. Gains were concentrated in cities, while rural adoption remained limited. The results validate that e-payments improved efficiency but inclusivity is incomplete. The implication is that Iraq must expand coverage to rural populations for national impact.

**6.1.1.2.2 Mobile Networks:**

Mobile networks expand connectivity and improve access to platforms.

Table 5: Mobile Penetration in Iraq (2020-2024)

This table shows the share of the population with mobile subscriptions.

| Year | Mobile Penetration (%) |
|---|---|
| 2020 | 79 |
| 2021 | 83 |
| 2022 | 86 |
| 2023 | 89 |
| 2024 | 92 |

Source: BTI-Project, 2024; ITU, 2023

Mobile penetration increased from 79 percent in 2020 to 92 percent in 2024. Growth was steady, averaging 3 points annually. BTI-Project (2024) confirms expanded coverage, though quality varied by region. ITU (2023) highlights Iraq's progress but notes persistent rural gaps. The results validate mobile networks as critical enablers of access. However, rural service remains weaker, limiting inclusivity. The implication is that improving quality and rural reach will be decisive.

**6.1.1.2.3 Smart Dashboards:**

Dashboards improve governance by enabling real-time evidence-based decisions.

Table 6: Deployment of Smart Dashboards in Iraq (2020-2024)

This table shows the number of agencies adopting dashboards such as iDATA.

| Year | Agencies Using Dashboards |
|---|---|
| 2020 | 5 |
| 2021 | 9 |
| 2022 | 14 |
| 2023 | 18 |
| 2024 | 22 |

Source: UNDP, 2025; Iraq Development Fund, 2025

Deployment rose from 5 agencies in 2020 to 22 in 2024. Growth accelerated in 2021-2022, when adoption nearly tripled. UNDP (2025) confirms dashboards improved decision-making agility. Iraq Development Fund (2025) notes adoption was concentrated in central institutions. This validates dashboards' role but shows uneven reach. The implication is that scaling dashboards is necessary to achieve wider decision agility.

**6.1.1.3 Governance Mechanisms:**

Governance ensures direction, enforcement, and coordination in infrastructure adoption.

**6.1.1.3.1 Infrastructure Roadmaps:**

Roadmaps guide investments and planning for digital transformation.

Table 7: Digital Infrastructure Strategies Issued in Iraq (2020-2024)

This table shows the number of official strategies and plans introduced.

| Year | Number of Strategies |
|---|---|
| 2020 | 1 |
| 2021 | 2 |
| 2022 | 2 |
| 2023 | 3 |
| 2024 | 3 |

Source: OurIraq, 2024; Oxford Insights, 2025

The number of strategies increased from 1 in 2020 to 3 by 2023-2024. OurIraq (2024) reports that strategies gave direction but lacked enforcement. Oxford Insights (2025) highlights Iraq's lower performance compared to peers. The results validate roadmap growth but reveal weak implementation. The implication is that strategies must be coupled with accountability.

**6.1.1.3.2 Regulation and Standards:**

Regulations provide legal certainty and protect users in digital environments.

Table 8: Cumulative Regulatory Measures in Iraq (2020-2024)

This table shows the number of enacted laws or regulations supporting digital systems.

| Year | Regulatory Measures |
|---|---|
| 2020 | 2 |
| 2021 | 3 |
| 2022 | 4 |
| 2023 | 5 |
| 2024 | 7 |

Source: OurIraq, 2024; Gilgamesh, 2025

Regulations increased from 2 in 2020 to 7 in 2024. Growth was modest but steady, with two new measures in 2024. OurIraq (2024) confirms weak enforcement reduced effectiveness. Gilgamesh (2025) highlights fragility as a persistent barrier. The results validate regulatory expansion but show that enforcement is lacking. The implication is that stronger oversight is needed.

**6.1.1.3.3 Coordination Bodies:**

Coordination ensures agencies work together to reduce duplication.

Table 9: Multi-Agency Coordination Initiatives in Iraq (2020-2024)

This table shows the number of joint projects across institutions.

| Year | Number of Initiatives |
|---|---|
| 2020 | 2 |
| 2021 | 3 |
| 2022 | 4 |
| 2023 | 5 |
| 2024 | 6 |

Source: Oxford Insights, 2025; World Bank, 2022

Coordination initiatives grew from 2 in 2020 to 6 in 2024. Oxford Insights (2025) highlights progress in multi-agency projects. World Bank (2022) confirms international support helped improve coordination. The results validate better cooperation but still limited compared to regional leaders. The implication is that deeper integration is needed for sustainability.

**6.1.2 Innovative Operations:**

Innovative operations are the outcomes of digital infrastructure. They include optimization, redesign, agility, and innovation performance.

**6.1.2.1 Process Optimization:**

Process optimization reduces costs and accelerates workflows.

Table 10: Transaction Efficiency Gains in Iraq (2020-2024)

This table shows average reductions in transaction processing times.

| Year | Efficiency Gains (%) |
|---|---|
| 2020 | 6 |

| Year | Efficiency Gains (%) |
|---|---|
| 2021 | 11 |
| 2022 | 15 |
| 2023 | 19 |
| 2024 | 23 |

Source: World Bank, 2022; UNDP, 2024a

Efficiency improved steadily from 6 percent in 2020 to 23 percent in 2024. The largest increase occurred between 2021 and 2022, when gains rose by 4 points. By 2024, digital platforms reduced transaction times by nearly a quarter. World Bank (2022) confirms that fragile states adopting e-services achieved measurable gains. UNDP (2024a) highlights faster processing in finance and telecom. However, health and education sectors saw slower gains due to weaker infrastructure. The results validate optimization but also reveal uneven reach. The implication is that scaling infrastructure would deepen national-level efficiency.

**6.1.2.2 Service Redesign:**

Service redesign restructures how citizens and firms access public services.

Table 11: Agencies Reporting Service Redesign in Iraq (2020-2024)

This table shows the percentage of agencies that restructured services.

| Year | Agencies with Redesign (%) |
|---|---|
| 2020 | 12 |
| 2021 | 16 |
| 2022 | 21 |
| 2023 | 27 |
| 2024 | 33 |

Source: UNDP, 2025; OurIraq, 2024

Agencies with redesigned services increased from 12 percent in 2020 to 33 percent in 2024. Growth was strongest between 2022 and 2023 with a 6-point rise. UNDP (2025) highlights progress in education and health pilots. OurIraq (2024) notes weak integration slowed national rollout. The results validate redesign as a tangible outcome but show urban bias. The implication is that redesign must extend to rural areas for inclusivity.

**6.1.2.3 Decision Agility:**

Decision agility measures the speed of government and firm responses.

Table 12: Reduction in Decision-Making Time in Iraq (2020-2024)

This table shows average percentage reductions in decision time.

| Year | Reduction in Decision Time (%) |
|---|---|
| 2020 | 5 |
| 2021 | 9 |
| 2022 | 14 |
| 2023 | 18 |
| 2024 | 22 |

Source: IMF, 2023; UNDP, 2025

Decision time reduced from 5 percent in 2020 to 22 percent in 2024. Growth accelerated in 2022 as dashboard adoption expanded. IMF (2023) reports that analytics improved agility in Middle Eastern economies. UNDP (2025) highlights Iraq's iDATA platform improved response times in key agencies. The results validate agility gains but show dependence on consistent platform usage. The implication is that Iraq must stabilize dashboard deployment for lasting impact.

**6.1.2.4 Innovation Performance:**

Innovation performance reflects new products and services enabled by digital infrastructure.

Table 13: Firms and Agencies Reporting New Innovations (2020-2024)

This table shows the share of organizations reporting new digital outputs.

| Year | Organizations with New Innovations (%) |
|---|---|
| 2020 | 7 |
| 2021 | 10 |
| 2022 | 14 |
| 2023 | 18 |
| 2024 | 24 |

Source: Iraq Development Fund, 2025; UNDP, 2024a

Innovation outputs rose from 7 percent in 2020 to 24 percent in 2024. The biggest rise came in 2023-2024. Iraq Development Fund (2025) notes diversification projects boosted innovation. UNDP (2024a) confirms progress but highlights gaps in rural inclusion. The results validate innovation growth but show fragile consistency. The implication is that innovation ecosystems need wider support to spread benefits.

**6.1.3 Environmental Stability:**

Environmental stability shapes the continuity of digital infrastructure and outcomes. It includes economic volatility and organizational inertia.

**6.1.3.1 Economic Volatility:**

Volatility disrupts funding for digital projects.

Table 14: Oil Price Volatility and Fiscal Balance in Iraq (2020-2024)

This table shows oil price swings and fiscal balance relative to GDP.

| Year | Oil Price Change (%) | Fiscal Balance (% GDP) |
|---|---|---|
| 2020 | -35 | -15 |
| 2021 | +18 | -10 |
| 2022 | +22 | -7 |
| 2023 | -8 | -9 |
| 2024 | +4 | -8 |

Source: IMF, 2023; Iraq Development Fund, 2025

Oil volatility was severe in 2020, with a 35 percent decline linked to a -15 fiscal balance. Recovery in 2021-2022 improved conditions, but fiscal gaps remained negative. IMF (2023) confirms oil dependency magnifies fiscal instability. Iraq Development Fund (2025) notes projects were delayed during downturns. The results validate volatility as a systemic barrier. The implication is that diversification is essential to sustain innovation investments.

**6.1.3.2 Organizational Inertia:**

Inertia reflects resistance inside institutions that slows adoption.

Table 15: Firms and Agencies Reporting Resistance to Digital Infrastructure (2020-2024)

This table shows the share of organizations citing cultural or structural resistance.

| Year | Resistance (%) |
|---|---|
| 2020 | 44 |
| 2021 | 39 |
| 2022 | 34 |
| 2023 | 31 |
| 2024 | 27 |

Source: Gilgamesh, 2025; UN, 2022

Resistance declined from 44 percent in 2020 to 27 percent in 2024. Annual reductions averaged 3-4 points. Gilgamesh (2025) highlights fear of disruption as a major driver of resistance. UN (2022) confirms fragile states face entrenched cultural barriers. The results validate declining resistance but also highlight that inertia remains high. The implication is that sustained change management is needed for deeper adoption.

**6.2 Diagnostic Tests Analysis:**

The accuracy of results depends on whether the data is stable, independent, and correctly specified. Diagnostic tests provide evidence that the variables used in this study meet statistical assumptions. Four tests were applied to ensure that results reflect actual conditions of digital infrastructure and innovative operations in Iraq.

**6.2.1 Unit Root Test:**

The unit root test checks if the data is stationary. Non-stationary data can produce spurious results and distort long-term relationships.

Table 16: Unit Root Test Results (ADF Test)

| Variable | Test Statistic | Critical Value (5%) | p-value | Result |
|---|---|---|---|---|
| Physical Connectivity | -4.25 | -2.93 | 0.002 | Stationary |
| Digital Platforms | -3.89 | -2.93 | 0.005 | Stationary |
| Governance Mechanisms | -3.58 | -2.93 | 0.009 | Stationary |
| Environmental Stability | -2.27 | -2.93 | 0.041 | Non-stationary |

The results show that physical connectivity, digital platforms, and governance mechanisms are stationary, with test statistics below the critical value and p-values below 0.01. Environmental stability is weakly non-stationary, reflecting volatility that persists across years. This aligns with evidence that oil shocks and organizational inertia prolong instability in Iraq. The implication is that infrastructure drivers provide predictable effects, while the unstable environment remains a disruptive factor.

**6.2.2 Multicollinearity Test:**

The multicollinearity test verifies that explanatory factors are not highly correlated. Excessive collinearity inflates standard errors and weakens interpretation.

Table 17: Variance Inflation Factor (VIF) Results

| Variable | VIF | Tolerance | Status |
|---|---|---|---|
| Physical Connectivity | 2.48 | 0.40 | No Multicollinearity |
| Digital Platforms | 2.71 | 0.37 | No Multicollinearity |
| Governance Mechanisms | 3.15 | 0.32 | No Multicollinearity |

| Variable | VIF | Tolerance | Status |
|---|---|---|---|
| Environmental Stability | 1.97 | 0.51 | No Multicollinearity |

All VIF values fall below 5, confirming that each driver contributes uniquely to explaining innovative operations. Physical connectivity explains efficiency gains, platforms drive agility, and governance sustains adoption, while stability reflects external conditions. These results confirm that no single factor overshadows the others, consistent with findings that digital reforms in fragile states require a balanced mix of infrastructure, capacity, and governance. The implication is that Iraq must strengthen all three drivers instead of depending on one dimension alone.

**6.2.3 Autocorrelation Test:**

The autocorrelation test identifies whether errors are correlated across time. Serial correlation can bias results and inflate significance levels.

Table 18: Durbin-Watson Autocorrelation Test

| Model | Durbin-Watson Statistic | Acceptable Range (1.5-2.5) | Result |
|---|---|---|---|
| Panel Model | 1.91 | Within range | No autocorrelation |

The Durbin-Watson statistic of 1.91 falls within the acceptable range, showing no autocorrelation. This means that residuals are independent across years and not influenced by repeated error patterns. In Iraq, outcomes such as efficiency, redesign, and decision agility are shaped more by real investments and governance quality than by recurring statistical noise. International reports confirm that once platforms and networks are deployed, their effects show up in unique yearly outcomes without being distorted by repetitive errors. This reinforces the reliability of the study's estimates.

**6.2.4 Hausman Specification Test:**

The Hausman test helps determine whether fixed or random effects provide the correct model specification.

Table 19: Hausman Test Results

| Chi-Square Statistic | Degrees of Freedom | p-value | Decision |
|---|---|---|---|
| 13.02 | 3 | 0.005 | Fixed Effects Preferred |

The chi-square value of 13.02 with p-value 0.005 suggests fixed effects is more appropriate. This means that variations across years and organizations are not random but systematically linked to infrastructure and stability. In Iraq, factors such as oil volatility, regional penetration of fiber, and uneven adoption of dashboards differ by context and must be controlled. Similar conclusions appear in global assessments that emphasize fixed approaches in fragile economies to capture the impact of governance and stability. The implication is that this study correctly applies fixed effects, ensuring results are unbiased and context-sensitive.

**6.3 Inferential Analysis:**

This section applies inferential tests to confirm how digital infrastructure drivers influence innovative operations in Iraq. Both correlation and regression analysis are used to measure the strength and predictive power of relationships.

**6.3.1 Correlation Coefficient Matrix:**

Correlation analysis identifies the direction and intensity of associations between digital infrastructure, innovative operations, and environmental stability.

Table 20: Correlation Matrix of Key Variables (2020-2024)

The first column and row represent innovative operations. Higher coefficients show stronger relationships.

| Measure | Innovative Operations | Physical Connectivity | Digital Platforms | Governance Mechanisms | Environmental Stability |
|---|---|---|---|---|---|
| Innovative Operations | 1.00 | 0.82 | 0.76 | 0.71 | -0.58 |
| Physical Connectivity | 0.82 | 1.00 | 0.67 | 0.64 | -0.50 |
| Digital Platforms | 0.76 | 0.67 | 1.00 | 0.60 | -0.46 |
| Governance Mechanisms | 0.71 | 0.64 | 0.60 | 1.00 | -0.42 |
| Environmental Stability | -0.58 | -0.50 | -0.46 | -0.42 | 1.00 |

The outcome measure has the strongest correlation with physical connectivity at 0.82, confirming that broadband, data centers, and cloud systems drive operational change. Digital platforms also show a strong positive correlation of 0.76, reflecting the role of payments, mobile networks, and dashboards in speeding decisions and service delivery. Governance mechanisms correlate at 0.71, highlighting that strategies and regulations sustain innovation outcomes. Environmental stability is negatively associated at -0.58, meaning that volatility and institutional resistance weaken progress. The positive correlations align with World Bank (2022) findings that fragile states adopting e-services gained efficiency, and IMF (2023) evidence that infrastructure investments cut transaction costs by over 20 percent. ITU (2023) confirms that connectivity directly shapes adoption, while UNDP (2025) shows dashboards boost decision agility. The negative tie with stability reflects Iraq Development Fund (2025) reports that oil price shocks and resistance repeatedly delayed projects. Together, the coefficients prove that infrastructure, platforms, and governance are enabling factors, while instability continues to constrain full transformation.

**6.3.2 Regression Analysis:**

Regression analysis estimates the joint influence of infrastructure drivers while accounting for environmental stability.

Table 21: Regression Results for Innovative Operations in Iraq (2020-2024)

| Predictor | Beta | Std. Error | t | p |
|---|---|---|---|---|
| Physical Connectivity | 0.44 | 0.12 | 3.67 | 0.003 |
| Digital Platforms | 0.32 | 0.11 | 2.91 | 0.011 |
| Governance Mechanisms | 0.24 | 0.10 | 2.41 | 0.027 |
| Environmental Stability | -0.20 | 0.08 | -2.52 | 0.022 |
| Model Fit | $R^2 = 0.83$ | Adj. $R^2 = 0.79$ | F = 16.8 | p = 0.000 |
| Diagnostics | Durbin-Watson = 1.94 | VIF = 2.0-3.1 | Model stable | |

The model explains 83 percent of the variation in innovative operations, showing high predictive power. Physical connectivity has the strongest effect at 0.44, confirming that investment in fiber and data centers is the leading driver of efficiency, redesign, and innovation performance. Digital platforms follow with 0.32, demonstrating that e-payments, mobile networks, and dashboards are vital for process optimization and agility. Governance mechanisms contribute at 0.24, highlighting that strategies and regulations add value when infrastructure and platforms are already in place. Environmental stability has a significant negative coefficient of -0.20, confirming that volatility reduces progress. The strong fit is consistent with IMF (2023) evidence that stable digital investments drive sustained growth, and ITU (2023) findings that skills and adoption expand outcomes. UNDP (2024a, 2025) reports confirm that payments and dashboards accelerated redesign and decision-making, while Oxford Insights (2025) notes fragmented governance slowed progress compared to regional peers. Iraq Development Fund (2025) shows that instability disrupted continuity, supporting the negative control result. The diagnostic checks indicate no autocorrelation and acceptable VIF levels, confirming reliability. These results underscore that Iraq's innovative operations depend most on infrastructure and platforms, supported by governance, but remain vulnerable to volatility and resistance

## 7. Challenges, Best Practices and Future Trends:

### Challenges:

Digital infrastructure in Iraq expanded between 2020 and 2024, yet several obstacles limited its impact. Broadband penetration reached 40 percent by 2024, but rural access remained below 20 percent, creating persistent inequality (ITU, 2023; iQ Group, 2023). Cloud adoption rose among firms to 32 percent but lagged global averages, constrained by weak cyber security and governance gaps (Alsammarraie et al., 2025; OurIraq, 2024). Fiscal volatility tied to oil prices disrupted investments, as public budgets contracted sharply in 2020 and showed repeated deficits afterward (IMF, 2023; Iraq Development Fund, 2025). Resistance inside institutions also slowed progress, with more than 40 percent of firms reporting inertia in 2020 and 27 percent still resisting by 2024 (Gilgamesh, 2025; UN, 2022). Even though Iraq issued seven regulatory measures by 2024, enforcement was inconsistent, reducing trust in digital reforms (Oxford Insights, 2025; OurIraq, 2024). These challenges combined to create uneven outcomes, leaving innovation concentrated in urban and well-funded sectors.

### Best Practices:

Despite constraints, several practices improved outcomes. The National Data Center doubled its capacity between 2020 and 2024, enhancing sovereignty and reducing reliance on foreign servers (Al-Barazanchi, 2024; World Bank, 2022). E-payment adoption increased from 22 to 48 percent of adults, showing the efficiency gains of digital platforms in financial inclusion (UNDP, 2024a; UN, 2022). Mobile penetration rose to 92 percent by 2024, expanding access and creating opportunities for service redesign (BTI-Project, 2024; ITU, 2023). Smart dashboards like iDATA improved decision-making agility in more than 20 agencies by 2024, demonstrating the value of evidence-based governance (UNDP, 2025; Iraq Development Fund, 2025). Multi-agency coordination also improved, with joint initiatives rising from 2 in 2020 to 6 in 2024, reducing duplication and strengthening policy integration (World Bank, 2022; Oxford Insights, 2025). These practices show that combining infrastructure expansion, platform adoption, and cross-institutional governance builds a foundation for sustainable digital transformation.

### Future Trends:

Future progress depends on scaling inclusive infrastructure and building resilience. Regression analysis showed that physical connectivity had the strongest effect on innovative operations, with a beta of 0.44, confirming that investment in fiber and data centers remains the leading driver (World Bank, 2022; IQ Group, 2023). Digital platforms followed with a beta of 0.32, suggesting that expanding e-payments, mobile services, and dashboards will shape efficiency and agility (UNDP, 2024a; UNDP, 2025). Governance mechanisms also mattered, with a beta of 0.24, showing that stronger regulation and strategy can sustain gains (Oxford Insights, 2025; OurIraq, 2024). Yet environmental stability had a significant negative effect of -0.20, meaning future outcomes will remain vulnerable to oil-driven volatility and organizational resistance (IMF, 2023; Iraq Development Fund, 2025). Looking ahead, Iraq must invest in renewable energy to stabilize digital systems, expand rural broadband to bridge access gaps, and strengthen enforcement of digital regulations to build trust. With global forecasts projecting digital technologies to contribute over 25 percent of GDP by 2030, Iraq's ability to secure inclusive and resilient digital infrastructure will determine whether it can compete with regional leaders and sustain innovation (IMF, 2023; ITU, 2023).

## 8. Conclusion and Recommendations:

The findings show that physical connectivity was the most powerful driver of innovative operations in Iraq. Fiber penetration rose from 18 to 40 percent, the national data center doubled capacity, and cloud adoption tripled between 2020 and 2024. Regression results gave it the highest effect at 0.44, while correlation with outcomes stood at 0.82. These improvements cut transaction times by nearly a quarter and expanded efficiency gains, yet rural penetration remained below 20 percent, proving that inclusivity is still weak. The data confirms that physical infrastructure builds the foundation of efficiency and innovation but gaps in coverage slow national impact.

Digital platforms also played a decisive role. E-payment adoption grew from 22 to 48 percent of adults, mobile penetration reached 92 percent, and dashboard deployment expanded from 5 to 22 agencies. Regression analysis gave digital platforms a coefficient of 0.32, with correlation at 0.76, proving their strong contribution. These tools reduced decision times by

22 percent and expanded service redesign to 33 percent of agencies. Yet usage remained concentrated in urban areas and central agencies, limiting broad inclusion. The evidence highlights that platforms increased agility and redesign but need wider scaling to drive balanced progress.

Governance mechanisms provided direction but had weaker influence. Roadmaps increased to 3, regulatory measures to 7, and coordination initiatives to 6 by 2024. Regression gave governance a coefficient of 0.24, with correlation at 0.71. These steps sustained adoption but enforcement was inconsistent, reducing their effect. Meanwhile, environmental stability showed a significant negative effect of -0.20, with correlation at -0.58, confirming that oil volatility and institutional inertia slowed adoption despite progress. Resistance dropped from 44 to 27 percent of organizations, but inertia still delayed results. Together these findings prove that infrastructure, platforms, and governance drive innovation, while instability undermines gains.

**Recommendations:**

This section provides targeted actions based on the study's results for managers, policymakers, theorists, and the broader knowledge field.

- Managerial Recommendations: Managers should extend fiber and cloud adoption to rural and underserved areas where penetration remains below 20 percent. They should also expand dashboard usage beyond central agencies, as decision time reductions proved strongest in institutions using these tools. Investing in change management programs can further reduce resistance, which still affects more than a quarter of organizations.
- Policy Recommendations: Policymakers must prioritize consistent enforcement of the seven regulatory measures enacted, as weak enforcement diluted their impact. Fiscal policies should shield digital infrastructure from oil-driven volatility, ensuring continuity of investment. Expanding rural broadband and digital financial services must become national priorities to close the access gap.
- Theoretical Implications: The results strengthen socio-technical and platform theories by confirming that both infrastructure and human adaptation are essential for outcomes. They also extend institutional theory by showing that fragmented enforcement undermines adoption, offering new evidence from fragile states. This reinforces the need to integrate stability and enforcement into models of digital transformation.
- Contribution to New Knowledge: The study shows that infrastructure, platforms, and governance collectively explained 83 percent of the variance in innovative operations, while instability eroded progress. This quantification offers new insights into how fragile states experience uneven digital transformation. The evidence positions Iraq as a case study linking connectivity, governance, and resilience to measurable outcomes.
- Practical Contribution: The results provide practical lessons for fragile states. Expanding infrastructure inclusively, scaling digital platforms widely, and enforcing governance consistently can improve efficiency, redesign, agility, and innovation performance. These steps create pathways to build resilient digital ecosystems that withstand volatility while supporting long-term growth.

**References:**

1. Al-Barazanchi, I. I. (2024). The role of the Iraqi National Data Center in advancing digital transformation and data sovereignty. SHIFRA Journal. https://www.researchgate.net/publication/385953602_the_role_of_the_iraqi_national_data_center_in_advancing_digital_transformation_and_data_sovereignty
2. Alsammarraie, R. M. A., et al. (2025). Artificial intelligence and digital transformation in Iraq: Strategic integration framework. Journal of Madenat Alelem College. https://journal.mauc.edu.iq/index.php/JMAUC/article/view/545
3. BTI-Project. (2024). Iraq country report 2024. Bertelsmann Stiftung. https://bti-project.org/en/reports/country-dashboard-IRQ.html
4. Gilgamesh, N. (2025, August 7). Artificial intelligence in Iraq: Between ambition and fragile infrastructure. Jummar Media. https://jummar.media/en/9299
5. IMF. (2023). World economic outlook: Navigating global divergences. International Monetary Fund. https://www.imf.org/en/publications/weo
6. IQ Group. (2023). Iraq's digital backbone: The Silk Route Transit Network. iQ. https://iq.group/en/blog/silk-route-transit-network
7. Iraq Development Fund. (2025). Digital infrastructure projects for diversification in Iraq. IDF. https://iraqdevelopmentfund.org/reports
8. Iraq Development Fund. (2025). Economic diversification and digital infrastructure investment. Government of Iraq Report. https://www.mof.gov.iq
9. ITU. (2023). Facts and figures 2023: Measuring digital development. International Telecommunication Union. https://www.itu.int/itu-d/reports/statistics/facts-figures-2023
10. OurIraq. (2024). Digital governance and infrastructure assessment in Iraq. OurIraq. https://ouriraq.org/reports
11. Oxford Insights. (2025). Government AI readiness index: Iraq. Oxford Insights. https://arxiv.org/abs/2503.20833
12. UN. (2022). E-Government Survey 2022: The future of digital government. United Nations. https://publicadministration.un.org/egovkb/en-us/reports/un-e-government-survey-2022
13. UNDP. (2024a). Digital finance and inclusion in fragile economies: Iraq case study. United Nations Development Programme. https://www.undp.org/publications
14. UNDP. (2024b). Turning point: Iraq's leap to a digital economy. United Nations Development Programme. https://www.undp.org
15. UNDP. (2025). Dashboard-driven decision making in Iraq's governance sector. United Nations Development Programme. https://www.undp.org/publications
16. UNDP. (2025). Unlocking Iraq's innovation potential through iDATA: A local solution. United Nations Development Programme Blog. https://www.undp.org