

Issues surrounding data centers in Ghana: Implications for data warehousing and enterprise analytics

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Keywords

Data centres, data warehousing, enterprise analytics, AI governance, data protection, digital infrastructure, Ghana.

Abstract

Ghana's data centre ecosystem faces persistent infrastructure, regulatory, and human-capacity challenges that limit its capacity to support data warehousing and enterprise analytics. Guided by the Technology-Organisation-Environment (TOE) framework, this study examines how technological, organisational, and environmental constraints influence the development and performance of data-driven systems within the country. A mixed-methods approach was adopted, combining qualitative interviews with key stakeholders and analysis of infrastructure indicators such as power reliability, connectivity, and data centre capacity. The findings reveal four major barriers: unreliable electricity supply, high operational costs associated with cooling, fragmented regulatory frameworks, and a shortage of skilled technical personnel. These challenges contribute to fragmented data environments, limited interoperability, and reduced effectiveness of data warehousing systems. Financial constraints and weak data governance practices further limit the adoption of advanced analytics and artificial intelligence technologies. As a result, organisations struggle to leverage data as a strategic asset. The study highlights the need for coordinated policy reforms, investment in digital infrastructure, and targeted capacity development. It contributes to the literature by applying the TOE framework to a resource-constrained context and by offering practical insights to strengthen enterprise analytics capabilities in Ghana.

Introduction

Data centres are the quiet backbone of any digital economy, the humming racks and cooling fans you never notice but depend on. Those unseen machines power cloud services, enterprise warehouses, analytics engines and mission-critical apps. In Ghana, where connectivity and latency can make the difference between a service that works and one that fails, where a single lag can frustrate a business transaction or stall a telemedicine consult, the performance and siting of these facilities matter a great deal; they shape how well the country can cope with the growing complexity of digital transformation across sectors (Gaorekwe & Bwalya, 2024).

Yet moving everything to the cloud is rarely straightforward. Concerns about security and privacy keep many organisations from full migration, nudging them into hybrid setups that must tie together on-premises and cloud data in practical, secure ways (Gaorekwe & Bwalya, 2024). That blended model is especially relevant in Ghana, where the very quality of data, incomplete records, inconsistent formats, and gaps in validation often defeat publication and downstream use (Nuhu et al., 2020). Layer on a shortage of trained personnel and the steep cost of advanced analytics tools, and making sense of messy, disparate datasets quickly becomes an uphill slog (Olaleye et al., 2024).

Fixing this requires more than expanding physical infrastructure. Investments must also target human capacity and institutional governance. This includes training data engineers and system administrators, establishing national data standards, strengthening cybersecurity practices, and creating clear frameworks for data stewardship so that information remains reliable, accessible, and secure (Raji et al., 2024; Offei, 2025). This is not academic hair-splitting. If Ghana hopes to use analytics to shape policy and drive economic growth, and demand for digital services will rise with population and urbanisation, those pieces must fit together (Twum et al., 2024).

This study maps those interlocking challenges and offers practical guidance on how Ghana might deliberately develop a data-centre ecosystem to support data warehousing and enterprise analytics (Adama & Okeke, 2024; Akal et al., 2019). A close reading of policy uncovers worrying gaps: Ghana's National Artificial Intelligence Strategy, for example, reveals weaknesses in AI governance and lacks an overarching

data strategy, a shortcoming that directly undermines the trustworthiness and utility of data for analysis (Offei et al., 2026; Israel, 2025).

The absence of coherent regulation and a national data policy also hamper secure, efficient data management, the very foundation of a sustainable AI ecosystem and a culture of data-driven innovation (Israel, 2025). That regulatory vacuum makes it harder to tackle data quality, privacy, and ethical compliance, yet those are precisely the conditions required for safe AI and advanced analytics (Aldoseri et al., 2023; Magakwe, 2025).

Compounding the problem are underinvestment in infrastructure and a scarcity of Africa-origin datasets. Together, these factors widen the digital divide, especially in informal urban settlements and rural areas where access and digital experience lag far behind more connected communities (Sinde et al., 2023; Twum et al., 2024). The response must be multi-pronged: shore up digital infrastructure, nurture local data ecosystems, and introduce comprehensive regulatory frameworks that support fair, resilient digital transformation (Oqubay, 2015).

That also means breaking down data silos and resolving interoperability headaches, while training a workforce that can navigate both the technical and ethical complexities of data analytics and AI (Olajiga et al., 2024; Raji et al., 2024). Deploying data-warehousing and enterprise analytics platforms successfully in Ghana will require technical fixes certainly, but it will also demand clear legal and ethical rules about how data are collected, stored and used (Masinde et al., 2025). This paper examines the current legal and policy landscape to identify gaps and opportunities for stronger data governance, drawing on national policy reviews and international good practice (Asare-Nuamah & Agyepong, 2016).

There are also strategic risks associated with aggressive AI investment. Limited national resources could be redirected away from essential services such as healthcare, education, or energy infrastructure. In addition, heavy reliance on foreign cloud providers and proprietary AI systems may create technological dependency, limiting Ghana's ability to develop sovereign digital capabilities (Frimpong, 2025).

Literature Review

Data Centre Challenges in Developing Countries

Data centres play a foundational role in enabling data warehousing and enterprise analytics, yet their development in emerging economies is constrained by structural and resource limitations. In many developing countries, including Ghana, the deployment and operation of data centres require substantial capital investment, reliable infrastructure, and specialised technical expertise, all of which remain limited (Okolo et al., 2022).

These constraints directly affect the ability of organisations to implement scalable data warehousing systems and advanced analytics platforms capable of processing large volumes of heterogeneous data (Ade-Ibijola & Okonkwo, 2023). The situation is further complicated by weak data engineering capacity, where fragmented, unstructured, and inconsistent datasets limit the effectiveness of AI training and data-driven decision-making (Nsarkoh et al., 2025).

In addition, inadequate investment in local data centre infrastructure increases dependence on external cloud providers, leading to higher latency, increased costs, and reduced control over data. This limits the development of local digital ecosystems and constrains innovation in enterprise analytics. As a result, data centres in developing countries remain underdeveloped, fragmented, and insufficient to support large-scale digital transformation.



Figure 1: Key data center locations in Ghana, highlighting the country's emerging role in West Africa's digital infrastructure. These facilities support growing demands for data warehousing, enterprise analytics, and cloud services, but raise concerns around energy consumption, security, and sustainability.

AI Governance and Data Policy Gaps in Africa

The effectiveness of data centres and analytics systems is closely linked to the strength of data governance and regulatory frameworks. Across many African countries, there is limited progress in establishing robust data protection regimes, oversight mechanisms, and institutional frameworks to support AI adoption (Diallo et al., 2025).

This has resulted in fragmented regulatory environments, where existing policies often fail to address emerging issues such as algorithmic bias, ethical AI use, and data sovereignty (Salihu, 2025). In many cases, countries rely on outdated data protection laws that do not adequately reflect the complexities introduced by artificial intelligence technologies (Diallo et al., 2025).

There is also a notable absence of dedicated regulatory frameworks for AI business practices and limited emphasis on governance, ethics, and capacity building within national policy discussions (Dzandu & Asiedu, 2025; Gikunda, 2024). These gaps hinder the development of context-specific AI strategies and slow progress toward building inclusive and locally relevant digital ecosystems (Ayana et al., 2024).

In Ghana, these challenges manifest in weak coordination across regulatory bodies and the absence of a comprehensive national data strategy. This limits trust in digital systems and constrains the effective use of data for enterprise analytics and decision-making.

Infrastructure and Environmental Constraints

Infrastructure and environmental factors present significant barriers to the efficient operation of data centres in developing countries. In Ghana's tropical climate, high ambient temperatures and humidity increase the need for advanced cooling systems, which significantly raise energy consumption and operational costs (Ebert et al., 2024; Mutiso, 2024).

Cooling requirements also contribute to increased water usage, creating additional sustainability challenges, particularly in regions facing water scarcity (Shumba et al., 2024). These environmental pressures affect the long-term viability of data centre operations and highlight the need for energy-efficient and climate-responsive designs.

Energy reliability remains another critical issue. Frequent power disruptions and dependence on fossil fuel-based energy sources increase operational risks and carbon emissions, further complicating efforts to build sustainable digital infrastructure (Mbuva et al., 2024).

Connectivity limitations also play a major role. In Sub-Saharan Africa, inadequate fibre infrastructure and underdeveloped peering ecosystems lead to high latency and reduced bandwidth, which negatively impact real-time data processing and analytics performance (Mutiso, 2024). These limitations increase reliance on international bandwidth, raising costs and limiting the localisation of digital services.

Addressing these challenges requires coordinated investment in energy infrastructure, renewable energy integration, efficient cooling technologies, and improved network connectivity to support high-performance data environments.

Conceptual Framework

This study is guided by the Technology-Organisation-Environment (TOE) framework developed by Tornatzky and Fleischer (1990), which explains how technological innovation adoption is influenced by three interacting dimensions: technological, organisational, and environmental contexts.

- The technological context includes data centre infrastructure, computing capacity, connectivity networks, and data engineering capabilities.
- The organisational context refers to internal factors such as financial resources, skilled personnel, and data management practices.
- The environmental context encompasses external influences, including regulatory frameworks, government policies, and market conditions.

In the context of Ghana, these dimensions interact to shape the development of data centre ecosystems and determine the effectiveness of data warehousing and enterprise analytics systems (Owusu, 2026). Constraints such as unreliable power supply, limited technical expertise, and fragmented governance structures illustrate how these factors collectively influence digital transformation outcomes (Maheshwari et al., 2025).

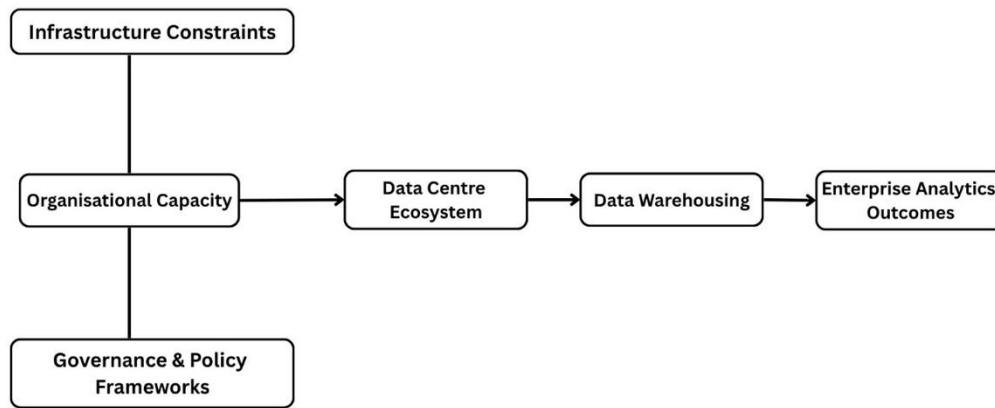


Figure 2: Technology–Organisation–Environment (TOE) framework illustrating the interaction of technological, organisational, and environmental factors shaping data centre ecosystems and their influence on data warehousing and enterprise analytics performance in Ghana (Author’s construct).

The conceptual model presented in Figure 1 provides the analytical foundation for this study. It explains how technological capabilities, organisational readiness, and environmental conditions jointly shape the development and performance of data centre ecosystems in Ghana. These interacting forces influence the efficiency of data warehousing systems and determine the extent to which organisations can adopt and sustain enterprise analytics solutions. The framework guides the interpretation of empirical findings by linking infrastructure constraints, institutional capacity, and regulatory conditions to observed limitations in data-driven systems. It also supports the identification of systemic bottlenecks that hinder digital transformation in resource-constrained environments. In this study, the TOE framework is used not only as a descriptive model but also as an analytical lens for examining how improvements in any one dimension may influence overall system performance.

Research Methodology

This section describes the layered, practical approach we took to untangle the tricky questions and possibilities around data centres in Ghana and what those mean for data warehousing and enterprise analytics. We mixed methods deliberately. On the qualitative side, the work leaned on conversations: interviews with sector experts, reviews of policy documents, and in-person stakeholder discussions that revealed how decisions are actually made messy at times, often pragmatic. For the quantitative side, we examined hard infrastructure indicators, such as internet penetration, energy consumption patterns, and current data centre capacity, so impressions were anchored to measurable facts (Soares et al., 2024). Stitching these threads together produced a fuller, less one-dimensional view of the technical limits and the socio-economic pressures shaping data centre development in Ghana.

The qualitative strand intentionally reached across the ecosystem: regulators, private operators, power utilities and academic researchers. Those voices surfaced policy gaps and operational bottlenecks that raw numbers tend to miss. The quantitative work then pushed back against those narratives, testing them and placing them in context. Together, the two approaches made it possible to offer pointed recommendations, for example, harmonising inconsistent regulations and fostering public–private partnerships, steps that look necessary for steady sector growth (Manu et al., 2025). That integrated posture matters in emerging economies; solutions have to fit local constraints if digital transformation is going to stick (Banda et al., 2024; Samuel-Okon & Abejide, 2024).

More specifically, the study used a qualitative comparative case-study design to surface the socioeconomic trade-offs and governance tensions tied to AI and infrastructure investments in resource-constrained settings like Ghana. We extended opportunity-cost thinking by bringing in political economy and digital governance lenses (Frimpong, 2025). We also relied on a multi-method toolkit, questionnaires, document review, observation and interviews to map actors and responsibilities in digital preservation and infrastructure planning (Adu, 2018). That mix produced a robust set of perspectives and empirical points, making the findings both pragmatic and policy-relevant for Ghana’s evolving digital landscape (Adjei & King, 2024; Chester, 2024).

Finally, semi-structured interviews and open-ended questionnaires formed the backbone of the qualitative work, giving us richer accounts of local perceptions and lived experience around data centre development and its implications for enterprise analytics and warehousing in Ghana (Arowolo-Ayodeji & Ernest, 2025; Hlongwane et al., 2024). These methods gave us more than tidy answers; they provided the context of the small, human trade-offs and everyday details that numbers alone rarely capture.

Results

The findings reveal four dominant barriers affecting data centre development and their ability to support data warehousing and enterprise analytics in Ghana: (1) regulatory fragmentation, (2) infrastructure limitations, (3) financial constraints, and (4) shortage of skilled personnel. These challenges collectively limit the ability of organisations to deploy scalable analytics platforms and AI-enabled services. The empirical findings, derived from the aforementioned methodologies, reveal significant insights into the operational challenges and strategic imperatives for data centres in Ghana. Specifically, institutional and regulatory conformity issues, along with technical integration and alignment incompatibilities, emerged as significant barriers to effective blockchain technology integration for online taxation, which has broader implications for secure data management within data centres (Anomah et al., 2024).

Furthermore, the absence of guiding policies and comprehensive life-cycle management practices for sustainable ICT infrastructure exacerbates these issues, hindering the transition towards environmentally responsible and energy-efficient data centre operations crucial for modern data warehousing and enterprise analytics (Shakemore et al., 2024). These systemic deficiencies also contribute to the limited adoption of artificial intelligence technologies, as robust data infrastructure is a prerequisite for AI implementation and innovation (Abulibdeh et al., 2023; Mutasa et al., 2024).

Moreover, financial constraints, coupled with a dearth of skilled human resources and inadequate technical support, further impede the widespread integration of advanced AI tools within Ghanaian academic institutions and, by extension, across various sectors (Adjei & Agyeman, 2025; Moharrak et al., 2024). This scarcity of local expertise and financial backing makes it challenging to maintain and upgrade the sophisticated infrastructure required for large-scale data warehousing and advanced enterprise analytics, thereby widening the digital divide (Dzandza, 2019; Ndhlovu, 2018). These multifaceted challenges collectively underscore the urgent need for strategic interventions that address both the technological and socio-economic impediments to Ghana's digital transformation, particularly concerning data infrastructure and AI adoption (Abulibdeh et al., 2023; Nwagbala et al., 2025; Patel & Ragolane, 2024). This includes addressing the low awareness of emerging technologies like AI and its potential benefits, which can significantly hinder adoption rates and limit the country's ability to leverage AI for national development (Adarkwah et al., 2023; Osondu et al., 2024).

Discussion And Conclusion

Interpretations of Findings

The preceding analysis underscores a critical need for Ghana to establish a cohesive national digital transformation strategy that transcends isolated sectoral initiatives (Loglo, 2024). This strategy must address the significant policy gaps, insufficient infrastructure, and skill deficits currently impeding the effective deployment of data centres and the broader digital economy (Ghana eTrade Readiness Assessment, 2023; Osondu et al., 2024). A well-defined national AI strategy, in particular, is crucial for fostering innovation and ensuring that Ghana is not left behind in the global digital economy, as evidenced by the experiences of other developing nations (Shonhe & Kolobe, 2023). Such a strategy would facilitate the establishment of innovation hubs and attract foreign investment, thereby strengthening Ghana's position in the global digital landscape (Frimpong, 2025).

Furthermore, integrating AI issues with discussions on the digital divide is timely for Africa, given that both emphasise leveraging technology to address societal inequalities and promote economic growth (Baidoo-Anu et al., 2024).

Latency and data ingestion are critical considerations for data centre development in Ghana, particularly in the context of advanced analytics and AI applications, where real-time data processing is paramount (Khan et al., 2024). This necessitates strategic investments in high-speed network infrastructure and localised data processing capabilities to minimise latency and optimise data throughput (Khan et al., 2024; Patel & Ragolane, 2024).

Moreover, compliance and data governance frameworks are essential to ensure the ethical and secure handling of sensitive data, especially when leveraging advanced analytics and artificial intelligence, to mitigate risks associated with data privacy and security (Falebata & Kok, 2024). Additionally, a robust regulatory environment is vital for fostering trust in digital services and encouraging broader adoption of data-intensive technologies across various sectors (Samuel-Okon & Abejide, 2024). While Ghana faces unique challenges, an overarching AI readiness strategy, similar to approaches in other African nations, is critical for improving outcomes in data infrastructure, technical capabilities, and policy prioritisation, thereby enabling the country to leverage AI-enabled technologies for improved governance and economic outcomes (Offei et al., 2026; Diallo et al., 2025).

This entails overcoming limitations in data access and infrastructure, as well as addressing the scarcity of political and economic resources, to genuinely progress towards AI readiness (Diallo et al., 2025). Achieving this readiness requires a concerted effort to bridge the existing digital divides and structural inequalities that hinder widespread AI adoption and integration across the continent (Arakpogun et al., 2021).

Conclusion

The preceding discussion has illuminated the multifaceted challenges and strategic imperatives confronting Ghana in its pursuit of robust data centre infrastructure, effective data warehousing, and advanced enterprise analytics capabilities. The prevailing issues, ranging from inadequate policy frameworks and financial constraints to the dearth of skilled human resources and technical infrastructure, collectively impede Ghana's progress in leveraging emerging technologies like artificial intelligence for national development (Diallo et al., 2025). These challenges are further compounded by a lack of tailored AI solutions for local contexts and inadequate data governance, which hinder equitable access to and implementation of AI technologies (Mienye et al., 2024).

Ghana's data centre sector is maturing, with notable investments and improving peering infrastructure creating opportunities for localised data warehousing and enterprise analytics. However, the full realisation of those opportunities depends on addressing persistent issues, such as power reliability and cost, efficient cooling solutions appropriate for a tropical climate, last-mile connectivity and peering maturity, regulatory compliance readiness, and a shortage of technical skills. These factors collectively underscore the necessity for comprehensive policy interventions and strategic investments aimed at fostering a resilient and sustainable digital ecosystem in Ghana (Diallo et al., 2025; Okolo et al., 2022).

Limitations And Future Research

Limitations

The study is constrained by the broader systemic challenges identified, including inadequate policy frameworks, limited financial resources, shortages in skilled human capital, and underdeveloped technical infrastructure, which may affect the generalisability and practical implementation of the insights presented. Additionally, the lack of tailored AI solutions for local contexts and inadequate data governance frameworks limits the extent to which findings can fully capture equitable access and effective deployment of AI technologies across different sectors (Mienye et al., 2024).

Directions for Future Research

To this end, developing a national AI strategy is paramount for Ghana to strategically integrate artificial intelligence into its digital transformation agenda, thereby setting a clear vision for AI adoption and utilisation (Shonhe & Kolobe, 2023). Future work should focus on empirical measurement of infrastructure performance indicators such as latency, uptime reliability, and energy efficiency across Ghanaian data centres. Such evidence would help guide national investments and support the development of resilient data infrastructures capable of sustaining large-scale analytics and AI deployment.

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