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Original article

The Reality of Big Data in Libya and Its Readiness to Support Artificial Intelligence Applications

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Abstract
Big Data has emerged as a critical driver of Artificial Intelligence (AI) innovation, enabling intelligent decision-making, predictive analytics, and automation across sectors. However, the readiness of developing nations to integrate Big Data into AI ecosystems remains underexplored. This study examines Libya's current Big Data landscape and its capacity to support AI applications. A mixed-methods approach was employed, combining desk research with semi-structured interviews involving eight stakeholders from government, academia, and the private sector. Findings reveal substantial deficiencies in infrastructure, data governance, policy frameworks, human capital, and institutional collaboration, which collectively hinder AI adoption. Benchmarking against advanced AI-ready nations such as Estonia and the United Arab Emirates (UAE) highlights Libya's significant lag in key readiness indicators. The study contributes to the literature on AI readiness in post-conflict and developing contexts, offering an empirically grounded analysis that identifies priority areas for intervention. Strategic recommendations are proposed, including the development of a national AI and Big Data strategy, the enactment of data governance legislation, targeted investments in ICT infrastructure, educational reforms, and mechanisms for cross-sector collaboration. These actions are essential to enable Libya to harness the socio-economic potential of AI and bridge the readiness gap with global leaders in digital transformation.
Keywords: Big Data, Artificial Intelligence, AI Readiness, Libya, Data Governance.

Introduction

In the era of digital transformation, Big Data has become a foundational resource for enabling Artificial Intelligence (AI) systems to learn, predict, and optimize complex processes. AI technologies rely on large-scale, diverse, and high-quality datasets to deliver applications in areas such as healthcare, governance, and industry [1-2]. Globally, many countries have made substantial investments in data infrastructure, governance mechanisms, and human capital development to leverage the transformative potential of AI [3]. Despite these advances, disparities persist between developed and developing countries in their ability to integrate Big Data into AI ecosystems. While advanced economies such as Estonia, the United Kingdom, and the United Arab Emirates (UAE) have implemented robust national AI strategies underpinned by comprehensive data frameworks, many developing nations face infrastructural, regulatory, and institutional challenges that limit AI adoption [4].

Libya represents a unique case within the developing world due to its prolonged political instability, fragmented institutional structures, and underdeveloped ICT infrastructure [5]. Although mobile penetration rates are relatively high, internet speed, coverage, and reliability remain inadequate. Furthermore, public sector data is often stored in paper-based formats or fragmented digital silos, limiting interoperability and scalability for AI systems.

While awareness of the importance of digital transformation is growing in Libya, the country lacks an integrated, coherent strategy to establish a national Big Data infrastructure capable of supporting AI adoption. Persistent challenges—such as outdated ICT systems, an absence of legal and regulatory frameworks for data governance, limited institutional coordination, and minimal investment in digital capacity—pose significant barriers to progress. Without immediate reforms, Libya risks widening the digital divide with global leaders, resulting in lost socio-economic opportunities and increased dependence on foreign technologies.

The primary aim of this study is to assess Libya's readiness to leverage Big Data for AI applications. The specific objectives are to evaluate the current state of Big Data infrastructure, governance, policy, human capital, and institutional collaboration in Libya, benchmark Libya's readiness against selected AI-leading countries, identify key barriers and opportunities for AI integration, and propose strategic recommendations to enhance national AI readiness.

Methodology

Research Design

This study adopts a mixed-methods research design, integrating both qualitative and quantitative approaches to provide a comprehensive assessment of Libya's Big Data readiness for Artificial Intelligence (AI) integration. The mixed-methods strategy was selected because Big Data readiness is inherently multidimensional, encompassing technical infrastructure, policy frameworks, human capital, and

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institutional collaboration. A purely quantitative analysis of national indicators would fail to capture the nuanced socio-political and organisational realities, while a purely qualitative approach might overlook measurable performance gaps [6].

The design, therefore, combines: Qualitative insights obtained from semi-structured interviews with key stakeholders allow for the exploration of perceptions, experiences, and institutional challenges. Quantitative benchmarking using secondary data from global ICT and AI readiness indices, enabling comparative analysis against leading AI-adopting countries such as Estonia and the United Arab Emirates (UAE).

The integration of these two strands allows for triangulation, enhancing the validity and reliability of the findings.

Population and Sampling

The target population for the qualitative component included stakeholders across four key sectors relevant to Big Data and AI development in Libya: Government institutions responsible for ICT policy, statistics, and public service digitalisation. Academic institutions offering programs in computer science, information systems, and data science. Private sector organisations involved in technology services, telecommunications, and digital infrastructure. Non-governmental organisations (NGOs) engaged in digital transformation and technology policy advocacy.

A purposive sampling strategy was applied to identify participants with substantial knowledge or decision-making authority in areas directly related to the five conceptual framework pillars (infrastructure, governance, policy, human capital, collaboration). A total of eight participants were recruited: 3 from government agencies, 2 from academia, 2 from the private sector, and1 from a non-governmental organisation. All participants had a minimum of seven years' professional experience in the ICT or policy domain. This sample size aligns with recommendations for qualitative studies requiring in-depth exploration of expert perspectives

Data Collection Methods

Desk Research (Quantitative Strand)

Secondary data was collected from authoritative global and national sources, including World Bank ICT and Governance Databases, to extract data on infrastructure investment, internet penetration, and institutional performance. United Nations ESCWA Digital Development Reports – to contextualise Libya's position in the MENA region. International Telecommunication Union (ITU) ICT Development Index – to benchmark telecommunications performance. OECD AI Readiness Indicators – for global comparison with advanced AI adopters. Government and NGO reports on Libya's ICT development initiatives. These datasets provided measurable indicators for internet speed, data center availability, cloud adoption rates, ICT investment as a percentage of GDP, and the presence of AI-related policies.

Semi-Structured Interviews (Qualitative Strand)

Semi-structured interviews were conducted between January and March 2025 to capture rich, contextualised insights. The interview guide was developed based on the conceptual framework and included both open-ended and closed-ended questions.

Sample questions included: "What are the major barriers to implementing Big Data initiatives in Libya?" "How would you assess the level of collaboration between government, academia, and the private sector in AI-related projects?" "What specific infrastructure improvements would have the most immediate impact on AI readiness?" Interviews lasted between 45 and 70 minutes and were conducted either face-to-face in Tripoli and Benghazi or via secure video conferencing platforms for participants located elsewhere. All sessions were audio-recorded with participant consent and later transcribed for analysis.

Data Analysis Procedures

The quantitative data from desk research were tabulated and normalised to allow for direct comparison between Libya, Estonia, and the UAE. Benchmarking techniques were employed to score Libya's performance across the five readiness pillars on a scale of 1 (very low readiness) to 5 (high readiness). The qualitative data from interviews were analysed using thematic coding in NVivo software. The coding process followed three stages: Open coding – identifying recurring patterns and themes from transcripts. Axial coding – linking these themes to the conceptual framework pillars.

Selective coding – integrating themes into broader analytical categories aligned with the study's objectives.

Triangulation was applied to validate findings by cross-referencing interview insights with quantitative benchmarks and documentary evidence.

Ethical Considerations

Ethical approval for the study was obtained from the Faculty of Information Technology, University of Aljufra. Participants were provided with an informed consent form detailing the study's aims, the voluntary nature of participation, and confidentiality measures. Anonymity was ensured by replacing participant

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names with coded identifiers (e.g., R1, R2). All collected data was stored on a password-protected, encrypted drive accessible only to the research team.

Limitations

While the study provides a robust evaluation of Libya's Big Data readiness, several limitations must be acknowledged: Sample size – only eight interview participants were included, limiting generalisability.
Data availability – some national statistics were outdated or unavailable, necessitating reliance on regional or proxy indicators.
Geographic scope – qualitative insights were predominantly drawn from stakeholders in Tripoli and Benghazi, potentially underrepresenting perspectives from other regions.
Despite these constraints, the mixed-methods approach and triangulation enhanced the reliability and validity of the findings, making them a credible basis for strategic recommendations.

Results

This section presents the integrated results from both desk research and semi-structured interviews, structured according to the five pillars of the Big Data Readiness Conceptual Framework: Infrastructure, Data Governance, Policy and Regulation, Human Capital, and Institutional Collaboration. Quantitative indicators are benchmarked against Estonia and the United Arab Emirates (UAE), while qualitative findings provide contextual explanations.

Infrastructure Readiness

Libya's digital infrastructure remains underdeveloped, with low internet speeds, minimal data center availability, and very low cloud adoption compared to benchmark countries. Interviewees highlighted outdated systems and frequent electricity disruptions as major barriers.

Table 1. Infrastructure Readiness Benchmarking

Indicator	Libya	Estonia	UAE	Observations (Libya)
Average internet speed (Mbps)	7.5	75.2	115.3	Significantly below the global average
Availability of data centres	Minimal	Moderate	Extensive	Few operational facilities
Cloud adoption level	Very Low	High	High	Limited enterprise adoption
National cloud infrastructure	No	Yes	Yes	No centralised platform
Public data centres	Very few	Moderate	Extensive	Concentrated in the capital only
ICT investment (% of GDP)	0.3%	2.5%	3.2%	Insufficient budget allocation

Data Governance Readiness

Libya lacks comprehensive data protection laws, open data portals, and data-sharing standards. Interviewees noted the absence of an authority responsible for national data governance, leading to fragmented and insecure systems.

Table 2. Data Governance Indicators

Dimension	Governance Status in Libya
National Data Law	None
Open Data Portal	Not available
Data Sharing Standards	Not defined
Ethics in AI	Not institutionalised

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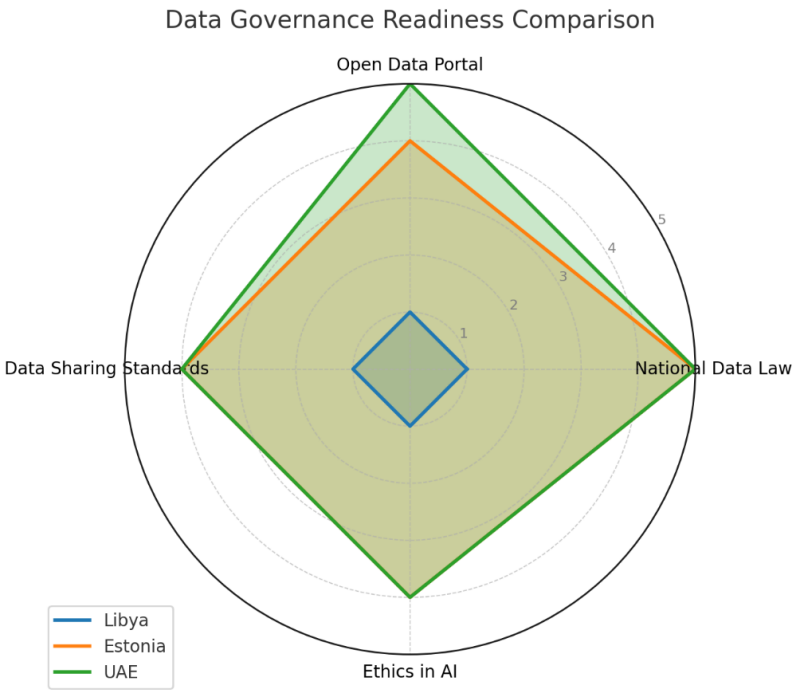

Figure 1. Libya's governance readiness (scale 1–5) compared to Estonia and the UAE, with Libya's scores concentrated near the center.

Policy and Regulatory Frameworks

Libya has no national AI strategy or centralised digital transformation roadmap. Institutional efforts are fragmented, with each body working in isolation.

Qualitative Insight:

"Each institution runs its pilot without coordination." (R1)

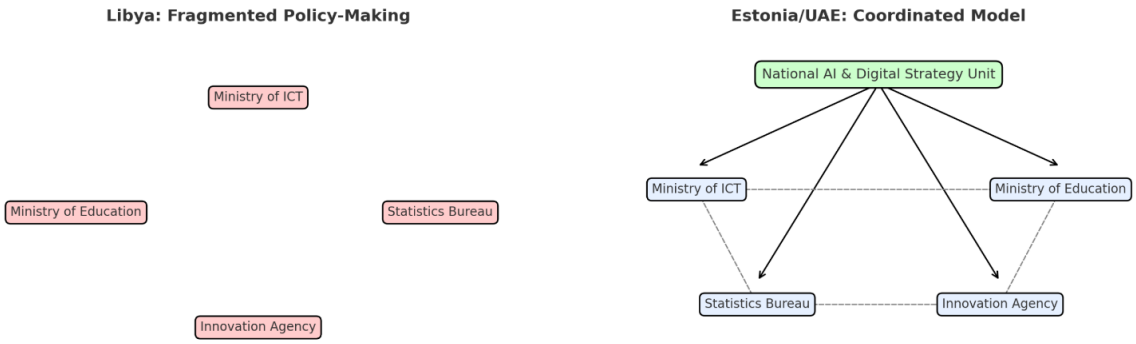

Figure 2. Flow diagram showing fragmented policy-making pathways in Libya versus a coordinated model (Estonia/UAE).

Human Capital and Skills

There is a severe shortage of AI and data science professionals, with limited university programmers, no national AI research centers, and minimal industry–academia partnerships.

Table 3. Human Capital Readiness

Dimension	Libya Status
AI-focused university programmers	Very limited
AI certifications availability	Absent
Access to online learning	Low
AI/Big Data research centers	None
AI/DS graduates per year	< 50
Industry partnerships	Minimal
AI training centers	None

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International collaboration	Sporadic, underfunded

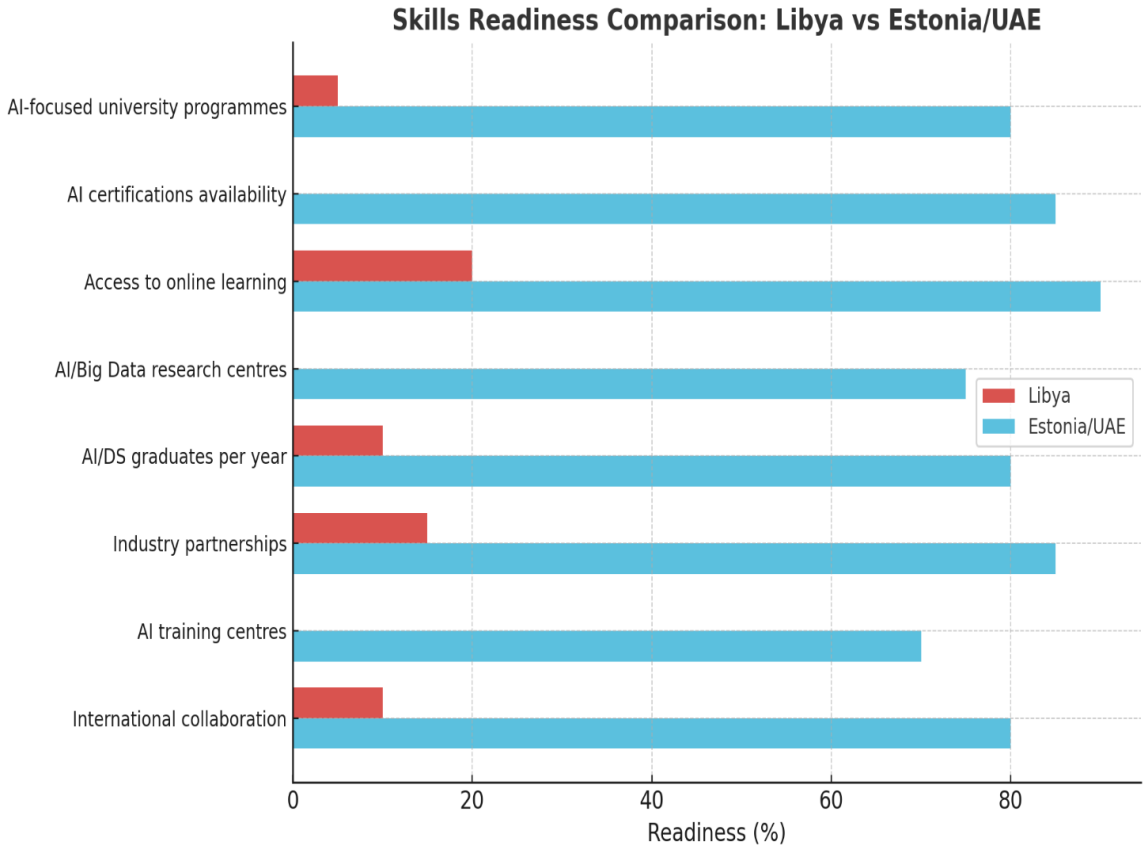

Figure 3. Stacked horizontal bar chart showing the percentage distribution of skills readiness in Libya versus Estonia/UAE.

Institutional Collaboration

Cross-sector collaboration is weak, with no national platform for data sharing or joint research initiatives. Interviewees reported a lack of leadership and incentives for partnership.

Qualitative Insight:"No incentives or leadership for data sharing or joint projects." (R4)

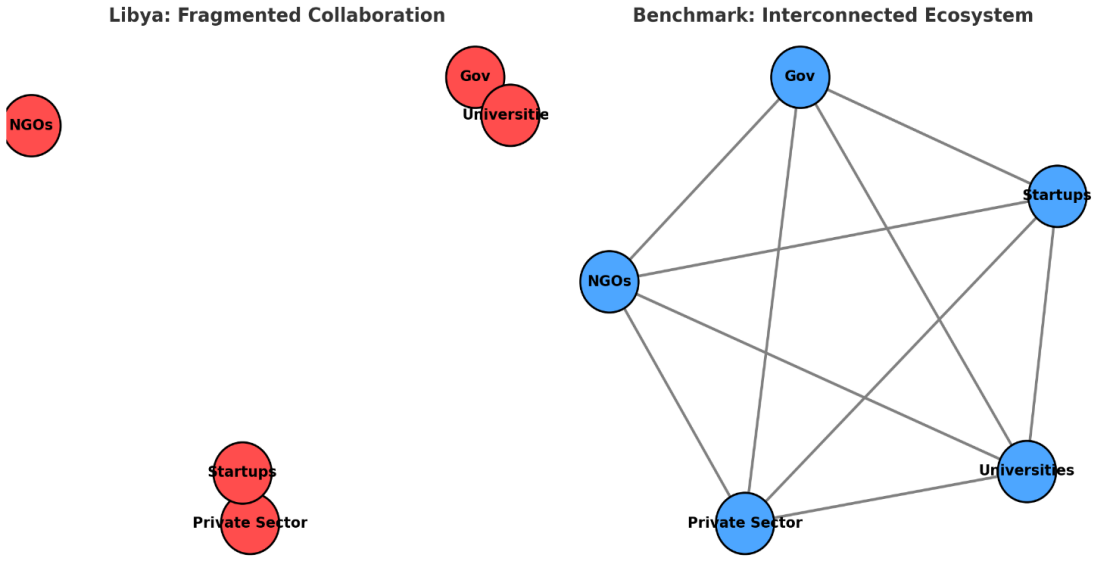

Figure 4. Network diagram comparing Libya's fragmented collaboration network to the interconnected ecosystem of a benchmark country.

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Overall Readiness Index

Table 4. Big Data Readiness Scores (Scale 1–5)

Dimension	Libya	Estonia	UAE
Infrastructure	1.5	4.7	4.9
Data Governance	1.2	4.5	4.7
Policy and Regulation	1.3	4.6	4.8
Human Capital	1.4	4.4	4.6
Institutional Collaboration	1.3	4.5	4.7

Discussion

The findings of this study provide a comprehensive evaluation of Libya's readiness to leverage Big Data for Artificial Intelligence (AI) applications. By integrating quantitative benchmarking with qualitative stakeholder perspectives, the research highlights critical deficiencies across all five readiness pillars—infrastructure, data governance, policy and regulation, human capital, and institutional collaboration—and situates Libya's position relative to global leaders such as Estonia and the United Arab Emirates (UAE).

Infrastructure Gaps and Digital Divide

The results confirm that Libya's infrastructure readiness is substantially below that of AI-ready nations. With an average internet speed of 7.5 Mbps, limited data center availability, and negligible cloud adoption, Libya's capacity to support large-scale AI initiatives is severely constrained. These deficiencies mirror trends observed in other post-conflict states where weak ICT investment perpetuates the digital divide [7].

Estonia's experience with its X-Road platform demonstrates how robust digital backbones not only enable AI deployment but also build citizen trust in e-services [3]. Similarly, the UAE's high-speed connectivity and extensive cloud infrastructure provide scalable platforms for AI integration across sectors. In contrast, Libya's reliance on outdated legacy systems, as reported by interviewees, exacerbates operational inefficiencies and limits innovation.

Weak Data Governance and Legal Frameworks

The absence of comprehensive data protection laws, open data portals, and data-sharing standards in Libya creates a fragmented and insecure environment for digital transformation. This aligns with Kaisler et al. (2013) [8], who argue that without well-defined governance frameworks, Big Data systems risk becoming isolated silos with low interoperability. Interview evidence indicates that no single entity in Libya is currently responsible for data governance, resulting in inconsistent practices across institutions. This situation undermines public trust, a critical factor for the successful adoption of AI in sensitive domains such as healthcare and finance [9]. Comparatively, the UAE's National Data Strategy and Estonia's data privacy protocols ensure both compliance with global standards and secure cross-institutional data exchange.

Policy Fragmentation and Strategic Deficit

A major barrier to Libya's AI readiness is the absence of a national AI strategy or integrated digital transformation roadmap. Instead, isolated pilot projects are conducted without coordination or scalability potential. This fragmentation reflects findings from [4] that developing nations often lack centralised oversight mechanisms for digital innovation.

By contrast, the UAE's AI Strategy 2031 offers a clear vision, measurable targets, and sector-specific AI roadmaps, illustrating the importance of strategic direction. Without a comparable framework, Libya risks inefficient resource allocation, duplication of efforts, and slow adoption of AI technologies.

Human Capital Deficits

Libya's shortage of AI and data science professionals—fewer than 50 graduates annually—is a significant obstacle to building domestic AI capacity. This shortage is compounded by the lack of specialised university programmers, the absence of AI research centers, and minimal industry–academia partnerships. These findings echo [10]. observation that skilled data scientists are essential for transforming data into actionable intelligence. In countries such as Estonia, investments in AI-focused curricula and vocational training have cultivated a workforce capable of both developing and sustaining AI solutions. For Libya, the current skills gap not only limits the adoption of advanced technologies but also risks deepening dependence on foreign expertise.

Institutional Collaboration Failures

The study reveals a systemic lack of collaboration between government, academia, and the private sector in Libya's digital ecosystem. This absence of coordinated initiatives stifles knowledge exchange and innovation, a pattern also noted in other MENA countries with low AI maturity [11].

In contrast, Estonia's inter-ministerial coordination and the UAE's public–private innovation hubs illustrate how collaboration accelerates AI integration. For Libya, building institutional bridges is essential to enable shared infrastructure, pooled expertise, and collective problem-solving.

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Implications for Libya's AI Readiness

The combined weaknesses across all readiness pillars place Libya at a significant disadvantage in the global AI race. The country risks falling further behind unless urgent, coordinated action is taken to address infrastructure deficiencies, enact governance frameworks, develop human capital, and foster cross-sector partnerships.

However, Libya's young demographic profile, geostrategic location, and diaspora expertise present untapped opportunities. If leveraged effectively, these assets could form the foundation of a resilient, AI-ready ecosystem. The challenge lies in mobilising political will, securing investment, and implementing a coherent strategy that aligns with global best practices while addressing Libya's specific socio-political realities.

Conclusion

This study has provided the first comprehensive, empirically grounded assessment of Libya's readiness to leverage Big Data for Artificial Intelligence (AI) applications. Using a mixed-methods approach—combining quantitative benchmarking with qualitative stakeholder insights—the analysis reveals systemic deficiencies across all five readiness pillars: infrastructure, data governance, policy and regulation, human capital, and institutional collaboration. Comparative benchmarking against advanced AI adopters such as Estonia and the United Arab Emirates (UAE) demonstrates that Libya lags significantly in digital infrastructure, governance frameworks, skills development, and strategic coordination. These weaknesses collectively limit the feasibility of deploying large-scale AI systems and risk excluding Libya from the socio-economic benefits of the global AI transformation. Despite these challenges, the study identifies critical opportunities: Libya's youthful population, emerging ICT initiatives, and the technical expertise of the Libyan diaspora offer potential entry points for transformation if supported by targeted reforms and strategic investments. The findings underscore the urgent need for an integrated national AI and Big Data strategy to close the readiness gap and position Libya to participate in the data-driven global economy.

Conflict of interest. Nil

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