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Informal Digital Transformation Among Sudanese Youth During Armed Conflict: Digital Adaptation, Livelihoods, and Community Resilience, 2023-2025

Mona Suliman

monaawadsuliman@gmail.com

The University of science and technology omdarman https://orcid.org/0009-0000-6749-1762

Research Article

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Abstract

This study examines informal digital transformation among Sudanese youth during the armed conflict that began in April 2023. Rather than treating digital transformation as a state-led or corporate modernization process, the paper analyzes youth-led, low-resource, and community-based digital practices that emerged under conditions of displacement, infrastructure disruption, economic contraction, and information insecurity. The study uses a conflict-sensitive secondary mixed-methods design combining digital-access indicators, programme documentation, case-based evidence, and thematic analysis of youth-oriented digital activity in education, livelihoods, humanitarian coordination, and civic engagement. The revised analysis corrects earlier overextension by limiting empirical claims to Sudan-specific evidence from 2023–2025 and treating South Sudan, Somalia, and Yemen only as comparative regional references. Findings suggest that Sudanese youth have relied on low-bandwidth platforms, offline learning tools, social-commerce practices, diaspora networks, and peer-to-peer coordination to sustain learning, income generation, mutual aid, and public communication. The paper argues that informal digital transformation is best understood as a form of crisis adaptation and community resilience rather than a substitute for formal digital infrastructure. It concludes with policy recommendations emphasizing offline-first design, digital safety, local ownership, renewable energy, transparent data governance, and targeted support for youth and women in conflict-affected communities.

1. Introduction

1.1 Background and context

The conflict that erupted in Sudan on 15 April 2023 between the Sudanese Armed Forces and the Rapid Support Forces transformed the country's social, economic, and institutional landscape. Formal education, banking, public administration, telecommunications, and humanitarian coordination were disrupted across many areas. Within this disruption, Sudanese youth did not simply withdraw from digital life; many adapted digital tools to sustain learning, income generation, mutual aid, and public communication under difficult conditions.

This paper uses the term informal digital transformation to refer to digital practices that are not primarily initiated, governed, or financed through formal state or corporate transformation programmes. These practices include WhatsApp-based business coordination, social-media commerce, remote learning groups, diaspora-supported crowdfunding, digital peace messaging, and low-bandwidth humanitarian coordination. They are informal not because they are unimportant, but because they often operate through improvised community networks, personal devices, platform workarounds, and trust-based social relations rather than stable institutional systems.

The revised manuscript deliberately narrows the empirical scope to Sudan between April 2023 and December 2025. Regional examples from South Sudan, Somalia, and Yemen are retained only for

comparison and policy learning, not as evidence about Sudanese youth themselves.

1.2 Research problem

Existing discussions of digital transformation often emphasize formal infrastructure, state digital strategies, platform regulation, and private-sector modernization. Such approaches are insufficient for conflict-affected contexts where formal systems are damaged or fragmented. In Sudan, youth-led digital adaptation appears to have played a significant role in everyday resilience, yet the evidence remains scattered across humanitarian reports, digital statistics, media accounts, programme documentation, and local narratives. The research problem is therefore the lack of systematic, conflict-sensitive analysis of how informal youth-led digital practices emerged, what they enabled, and what risks they produced during the conflict period.

1.3 Research questions

1. How have Sudanese youth adapted digital tools for education, livelihoods, community coordination, and civic engagement during the 2023–2025 conflict period?
2. What enabling conditions made informal digital adaptation possible despite infrastructure, electricity, financial, and security constraints?
3. What risks and exclusions accompanied these digital practices, including misinformation, surveillance, gendered access barriers, and digital divides?
4. How can policy actors support youth-led digital resilience without undermining community ownership or exposing users to additional harm?

1.4 Contribution

The paper contributes to ICT4D, youth studies, and conflict-resilience literature in four ways. First, it reframes digital transformation in Sudan as a bottom-up, informal process rather than a purely institutional programme. Second, it links youth digital adaptation to established theories of capabilities, resilience, innovation diffusion, and social capital. Third, it separates verified baseline indicators from estimates and projections to improve transparency. Fourth, it provides practical policy recommendations grounded in low-connectivity and conflict-sensitive realities.

2. Literature Review and Theoretical Framework

2.1 Digital transformation beyond formal institutions

Digital transformation is often defined as the integration of digital technologies into organizational, social, and economic systems. In fragile and conflict-affected settings, however, transformation may occur through informal, decentralized, and improvised practices. Mobile phones, messaging applications, solar charging, offline content, and diaspora communication channels can become more

consequential than formal portals or state platforms. This paper therefore uses a broader definition that includes informal, community-led, and survival-oriented digital adaptation.

2.2 Youth agency in crisis

Youth in conflict settings are frequently represented as victims, combatants, or beneficiaries of aid. A youth-agency perspective instead recognizes young people as problem-solvers who use available resources to negotiate constraints, support households, circulate information, and create new livelihood practices. In the Sudanese context, this perspective is essential because many digital practices are mediated by young people who are more likely to operate social media pages, manage WhatsApp groups, translate online information, facilitate mobile payments, or connect communities with diaspora support.

2.3 Theoretical framework

The analysis integrates four complementary theories. The Capability Approach helps examine how digital tools expand or constrain people's real opportunities to learn, communicate, earn income, and participate in community life. Resilience Theory highlights how individuals and communities absorb shocks, adapt to disruption, and reorganize under stress. Innovation Diffusion Theory explains how low-cost, trusted, and observable practices spread through peer networks. Social Capital Theory clarifies why trust, family ties, neighbourhood groups, diaspora networks, and professional communities are central to digital adoption during conflict.

Table 1
Theoretical framework and analytical use.

Theory	Use in this study	Example in Sudanese youth digital adaptation
Capability Approach	Assesses whether digital tools expand meaningful choices under constraint.	Remote learning, digital skills, online income opportunities.
Resilience Theory	Explains adaptation to shocks and infrastructure breakdown.	Offline-first education, solar-powered access, mutual aid coordination.
Innovation Diffusion Theory	Explains spread of practices through peer influence and perceived usefulness.	WhatsApp commerce, Telegram information channels, peer learning groups.
Social Capital Theory	Highlights trust networks as infrastructure for adoption.	Diaspora fundraising, neighbourhood groups, student networks.

Note. The theories are used analytically throughout the findings and discussion rather than treated as separate background concepts.

3. Methodology

3.1 Research design

The revised study uses a desk-based, conflict-sensitive mixed-methods secondary analysis. It combines quantitative indicators from digital and humanitarian reports with qualitative case synthesis from programme documents, media reports, and organizational publications. The term mixed-methods is used here in a secondary-data sense; the study does not claim to have conducted original interviews, surveys, or direct field observation.

3.2 Data sources

The evidence base was organized into four categories: official and statistical sources, programme documentation, triangulated humanitarian/media reports, and clearly labelled estimates or projections. Quantitative baseline indicators were drawn from sources such as DataReportal and other public digital-statistics repositories. Case evidence was drawn from reports and documentation concerning e-learning, digital skills, humanitarian coordination, and community initiatives. Regional examples were included only where they clarified comparative lessons.

Table 2
Evidence grading and reliability treatment.

Evidence grade	Definition	Use in manuscript	Treatment
A	Official or directly published statistical data from recognized data providers.	Digital access baseline, internet users, mobile connections.	Used as empirical baseline.
B	Programme documentation from UN agencies, NGOs, or development actors.	Learning platforms, training initiatives, community hubs.	Used for case description, with scope stated.
C	Triangulated media, NGO, or humanitarian reporting.	Digital harms, telecommunications disruption, community coordination.	Used cautiously and cross-checked where possible.
D	Author estimates, scenarios, or projections.	Future targets and policy pathways.	Separated from findings and labelled as projections only.

Note. The revised manuscript avoids presenting grade D projections as observed empirical findings.

3.3 Case selection criteria

Cases were selected if they met three criteria: (1) direct relevance to Sudan during 2023–2025, (2) clear connection to youth, education, livelihoods, community coordination, or digital civic activity, and (3) availability of at least one identifiable source or programme description. Initiatives located in South Sudan, Somalia, or Yemen were excluded from the Sudan findings and moved to the comparative section only.

3.4 Data extraction and analysis

Data were extracted into a matrix covering source type, year, geography, target group, platform or technology, enabling factors, reported outcomes, risks, and evidence grade. Thematic analysis was then conducted using four main codes: education continuity, livelihoods and social commerce, humanitarian coordination and mutual aid, and civic communication and activism. Cross-cutting codes included gender, digital safety, infrastructure, electricity, displacement, and local ownership.

3.5 Ethics and conflict sensitivity

Because the study concerns a live conflict environment, the revised manuscript avoids exposing private individuals, unpublished community groups, sensitive locations, or personal social-media accounts. It relies on public or organizational sources, avoids naming vulnerable participants, and treats digital activism and mutual-aid coordination as potentially risky activities. The analysis follows a do-no-harm principle: policy support should strengthen safe access, digital literacy, and community ownership without increasing surveillance, repression, or platform-based harassment.

3.6 Limitations

The study is limited by data gaps, uneven reporting across regions, changing platform methodologies, conflict-related access restrictions, and the difficulty of measuring informal digital economies. Social-media statistics should not be interpreted as counts of unique people unless the source explicitly states so. Programme outputs should not be generalized to all Sudanese youth without caution. These limitations are treated as part of the findings rather than ignored.

4. Digital Landscape in Sudan, 2023–2025

4.1 Corrected 2025 digital baseline

The revised paper replaces the earlier multi-year growth table with a corrected 2025 baseline and source notes. DataReportal reported that Sudan had 21.6 million cellular mobile connections in early 2025, equivalent to 42.4% of the population. The same source reported 14.6 million internet users, representing 28.7% penetration, and 3.68 million social media user identities, equivalent to 7.2% of the population. Crucially, mobile connections decreased by 5.6 million (-20.6%) between the start of 2024 and early 2025, so the earlier table showing positive mobile-connection growth has been removed. The revised text also notes that social-media identities may not equal unique individuals and should be compared cautiously across years.

Table 3
Corrected Sudan digital baseline, early 2025.

Indicator	Early 2025 value	Population equivalent / trend note	Evidence grade
Population	50.8 million	January 2025 estimate.	A
Cellular mobile connections	21.6 million	42.4% of population; decreased by 5.6M (-20.6%) from early 2024.	A
Internet users	14.6 million	28.7% internet penetration; internet users increased by 230,000 (+ 1.6%) from early 2024.	A
Offline population	36.3 million	71.3% of the population remained offline at the start of 2025.	A
Social media user identities	3.68 million	7.2% of population; identities are not necessarily unique individuals.	A

Source: DataReportal, Digital 2025: Sudan. Figures should be interpreted with the source's methodological cautions, especially for social-media identities.

4.2 Implications of the baseline

The baseline shows a contradictory digital environment. On one hand, 14.6 million internet users and 21.6 million mobile connections represent a substantial base for digital adaptation. On the other hand, the majority of the population remained offline in early 2025, and mobile connectivity contracted sharply compared with the previous year. Informal digital transformation in Sudan should therefore not be described as universal digital inclusion. It is better understood as uneven digital adaptation by connected or intermittently connected users who often mediate access for wider households and communities.

4.3 Infrastructure, access, and platform dependence

The conflict intensified dependence on mobile devices, low-bandwidth messaging, solar charging, diaspora communication, and intermittent connectivity. For many communities, WhatsApp, Facebook, Telegram, SMS, and offline content repositories became practical tools because they were familiar, relatively low-cost, and adaptable. However, this dependence also created vulnerabilities: platform shutdowns, misinformation, scams, surveillance, gendered harassment, high data costs, and exclusion of people without devices or digital literacy.

5. Findings: Key Dimensions of Informal Digital Transformation

5.1 Education continuity and skills learning

Education was one of the most visible areas of digital adaptation. With formal schooling and university routines disrupted, youth and educators used online courses, messaging groups, recorded lectures, PDFs, peer-learning circles, and offline materials to maintain learning. The strongest models were not necessarily high-bandwidth platforms; rather, offline-first and low-bandwidth designs were more suitable for conflict conditions. Programmes such as Learning Passport-style offline education and digital-skills initiatives illustrate how formal and informal approaches can intersect when content, devices, electricity, and community facilitation are aligned.

5.2 Livelihoods, social commerce, and informal digital work

Economic disruption pushed many young people toward social-commerce and platform-mediated work. Facebook pages, WhatsApp groups, Instagram accounts, Telegram channels, and informal delivery networks supported product sales, service advertising, tutoring, design work, translation, digital marketing, and remittance-related coordination. These practices created survival income, but they also exposed youth to payment fraud, weak consumer protection, exchange-rate instability, platform dependency, and lack of formal recognition.

5.3 Humanitarian coordination and mutual aid

Digital platforms supported mutual aid by circulating information about safe routes, medical needs, missing persons, food distribution, donation requests, education spaces, and local service availability. Low-bandwidth coordination mattered because many users could not rely on stable broadband. Informal digital coordination was often effective because it built on pre-existing social capital: neighbourhood trust, student networks, professional groups, family ties, and diaspora contacts.

5.4 Civic communication, activism, and peace messaging

Youth used digital platforms to document experiences, circulate peace messages, counter rumours, and connect displaced communities with wider audiences. Digital activism during conflict is double-edged: it enables visibility and transnational advocacy, but also increases exposure to surveillance, harassment, misinformation, doxxing, and political manipulation. The revised manuscript therefore treats activism not only as empowerment, but as a field requiring digital safety and careful risk assessment.

5.5 Cross-cutting risks and exclusions

The benefits of informal digital transformation were uneven. Youth with smartphones, digital literacy, language skills, electricity access, and diaspora networks were better positioned to benefit. Women and girls may face additional barriers related to device access, mobility, safety, harassment, and household control over technology. Rural areas, displaced communities, older users, and low-income households may depend on intermediaries rather than direct access. These inequalities mean that informal digital transformation can reduce some barriers while reinforcing others.

Table 4
Main dimensions, benefits, and risks of informal digital transformation.

Dimension	Common tools/practices	Main benefits	Main risks
Education	Offline content, WhatsApp groups, recorded lectures, e-learning platforms.	Learning continuity, peer support, flexible access.	Unequal device access, weak assessment, content quality gaps.
Livelihoods	Facebook/Instagram commerce, WhatsApp sales, freelance services.	Income generation, customer reach, diaspora links.	Fraud, payment instability, lack of consumer protection.
Humanitarian coordination	Messaging groups, donation posts, Telegram channels, SMS.	Fast local information, mutual aid, route and service updates.	Misinformation, privacy risks, exploitation.
Civic communication	Social media campaigns, digital storytelling, diaspora advocacy.	Visibility, peace messaging, public participation.	Surveillance, harassment, political manipulation.

6. Sudan-Specific Case Studies

This section presents Sudan-focused cases only. South Sudan initiatives that appeared in the earlier draft have been removed from the Sudan findings and moved to the comparative section. The cases below are included because they illustrate mechanisms of digital adaptation rather than because they represent all Sudanese youth.

Table 5
Revised Sudan-focused case-study matrix.

Case	Digital mechanism	Youth/community relevance	Evidence grade	Analytical lesson
Learning Passport-style offline education	Offline or low-bandwidth learning content and structured digital curriculum.	Supports continuity for children and young learners when schools are disrupted.	B	Offline-first design is essential where connectivity is unstable.
UNITAR digital and livelihood training	Online training focused on digital and entrepreneurial skills.	Targets youth and women seeking livelihood options during crisis.	B	Skills programmes need follow-up, job linkage, and local market alignment.
Solar-powered learning centres	Solar power, tablets, local content, shift-based access.	Addresses electricity barriers for learning in affected areas.	B	Renewable power can convert device access into sustained learning access.
WhatsApp and Telegram mutual-aid groups	Low-bandwidth coordination through trusted networks.	Supports local information sharing, donations, services, and community response.	C	Social capital can function as emergency digital infrastructure.
Social-media micro-enterprises	Facebook/Instagram pages, WhatsApp customer communication.	Youth-led commerce and service provision under economic disruption.	C/D	Informal business growth requires safer payments and consumer protection.

Note. Evidence grades distinguish verified programme documentation from triangulated reports and estimates. Cases are analytical examples, not a representative survey sample.

6.1 Education case synthesis

The education cases show that digital learning in Sudan cannot be reduced to internet connectivity alone. Devices, power, offline content, adult facilitation, safety, and local language all shape whether digital education is usable. The strongest implication is that emergency education policy should prioritize offline-first content packages, solar energy, teacher support, and gender-inclusive access rather than relying only on live online classes.

6.2 Livelihood case synthesis

Livelihood cases show that young people use familiar platforms to compensate for formal market breakdown. However, informal digital business is not automatically sustainable. It depends on payment channels, trust, delivery logistics, customer verification, exchange-rate stability, and platform

accessibility. Support should therefore focus on safer digital payments, micro-enterprise training, digital consumer protection, and links between informal sellers and formal support systems.

6.3 Humanitarian and civic case synthesis

Humanitarian and civic cases show the centrality of trusted peer networks. WhatsApp groups and Telegram channels are technically simple but socially complex: they rely on known admins, trusted contacts, and local verification. Policy interventions should avoid replacing these networks with top-down systems. Instead, they should strengthen safety, verification, data protection, and access to reliable information.

7. Comparative Regional Perspective

This section is comparative only. South Sudan, Somalia, and Yemen are not treated as evidence about Sudanese youth. They are used to identify policy lessons that may be relevant to Sudan's post-conflict digital recovery.

Table 6
Comparative lessons separated from Sudan-specific evidence.

Country	Relevant lesson	Caution for Sudan
South Sudan	Rural digital inclusion and humanitarian communication models can inform low-infrastructure service delivery.	Do not merge South Sudan evidence into Sudan findings; keep it comparative.
Somalia	Mobile money and diaspora-linked digital finance show the value of regulatory clarity and market competition.	Sudan's regulatory, banking, and security context differs; direct transfer is not possible.
Yemen	Low-tech and community-led education models show how radio, SMS, and offline learning can support conflict-affected learners.	Heavy donor dependence can weaken sustainability if local ownership is not built.

8. Discussion

8.1 Informal digital transformation as crisis adaptation

The findings suggest that Sudanese youth digital practices during the conflict are best understood as crisis adaptation. They are not equivalent to a formal national digital transformation strategy. They are partial, uneven, improvised, and often risky. Yet they are socially significant because they help households and communities maintain learning, income, communication, and mutual support under severe disruption.

8.2 Theoretical interpretation

From the Capability Approach perspective, digital tools expanded some practical freedoms, especially for connected youth who could learn, work, communicate, and support others. From a resilience

perspective, low-bandwidth platforms and offline systems functioned as adaptive mechanisms under shock. Innovation Diffusion Theory explains why familiar and observable tools such as WhatsApp spread more easily than complex platforms. Social Capital Theory explains why trust networks, diaspora ties, and peer groups often mattered more than technology alone.

8.3 The paradox of digital resilience

The central paradox is that the same digital systems that enabled resilience also produced risk. Social media helped commerce and mutual aid, but also enabled scams and misinformation. Messaging groups supported emergency coordination, but also created privacy and surveillance concerns. Offline education reduced dependence on internet connectivity, but still required devices, electricity, and maintenance. Effective policy must therefore avoid both digital romanticism and digital pessimism. Informal digital transformation is neither a cure-all nor a danger in itself; it is a contested survival infrastructure that requires careful support.

9. Policy Recommendations

The revised recommendations are shorter and directly linked to the findings. Detailed 2026–2030 budgets and speculative targets from the earlier draft have been removed from the main article and reframed as optional policy scenarios rather than empirical conclusions.

Table 7
Revised policy recommendations.

Policy area	Recommendation	Rationale
Connectivity and power	Support decentralized connectivity, solar charging, and offline-first access points in conflict-affected areas.	Digital access depends on electricity and intermittent connectivity, not internet alone.
Education	Scale offline digital learning packages with teacher support, local language content, and gender-sensitive access.	Education continuity requires content, facilitation, devices, and safe spaces.
Livelihoods	Provide youth micro-enterprise support, digital payment literacy, consumer protection, and safer marketplace practices.	Social commerce is already active but exposed to fraud and instability.
Digital safety	Train youth, educators, and community admins on privacy, misinformation verification, harassment response, and secure communication.	Digital resilience without safety can expose users to harm.
Local ownership	Fund community-led initiatives and peer networks rather than imposing fully external platforms.	Trusted social networks are core to adoption and sustainability.
Data governance	Require transparent indicators, source notes, and ethical safeguards for any digital-response programme.	Conflict settings increase risk of misuse, surveillance, and unreliable measurement.

9.1 Optional roadmap for 2026–2030

A future roadmap may be useful for policy planning, but it should be presented as a scenario rather than as a finding of the 2023–2025 study. A cautious roadmap would include: emergency stabilization in 2026, recovery and scale-up in 2027–2028, and institutional integration in 2029–2030. Targets should only be finalized after a fresh baseline survey, stakeholder consultation, and feasibility assessment.

Table 8
Scenario-based roadmap, separated from empirical findings.

Phase	Main priority	Examples of measurable indicators
2026: Stabilization	Protect existing access and restore minimum connectivity for education and humanitarian coordination.	Number of functioning community access points; number of teachers trained; number of safe digital-literacy sessions.
2027–2028: Recovery and scale-up	Expand offline-first education, youth enterprise support, and digital safety programmes.	Youth trained; women's participation; verified digital micro-enterprises supported; content localized.
2029–2030: Integration	Integrate successful informal models into formal education, finance, and governance systems.	Digital policy adoption; interoperable payment safeguards; community hubs sustained by local institutions.

10. Limitations and Future Research

The study is limited by its reliance on secondary data, uneven geographic coverage, rapidly changing connectivity conditions, and incomplete measurement of informal digital economies. The analysis cannot claim statistical representativeness of all Sudanese youth. Future research should include interviews with youth entrepreneurs, educators, women-led digital initiatives, displaced students, and community administrators, subject to strict ethical safeguards. A future mixed-methods field study should also measure gender, rural-urban differences, income effects, safety risks, and the sustainability of offline-first models.

11. Conclusion

Sudanese youth have used digital tools during the 2023–2025 conflict not as a smooth transition into a modern digital economy, but as a set of improvised survival, learning, livelihood, and coordination practices. The revised manuscript shows that informal digital transformation in Sudan is uneven but significant. It is enabled by low-bandwidth platforms, social trust, youth agency, diaspora links, offline content, and renewable power. It is constrained by infrastructure damage, affordability, digital literacy gaps, gendered exclusion, misinformation, and digital safety risks.

For publication and policy relevance, the key argument is that informal digital transformation should be supported without being romanticized. Its value lies in the ability of communities and youth to adapt

under extreme constraints, but its sustainability depends on safer infrastructure, transparent data, local ownership, inclusive design, and careful governance. Sudan's post-conflict digital recovery should therefore learn from these informal practices while addressing the inequalities and risks that shaped them.

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Figures

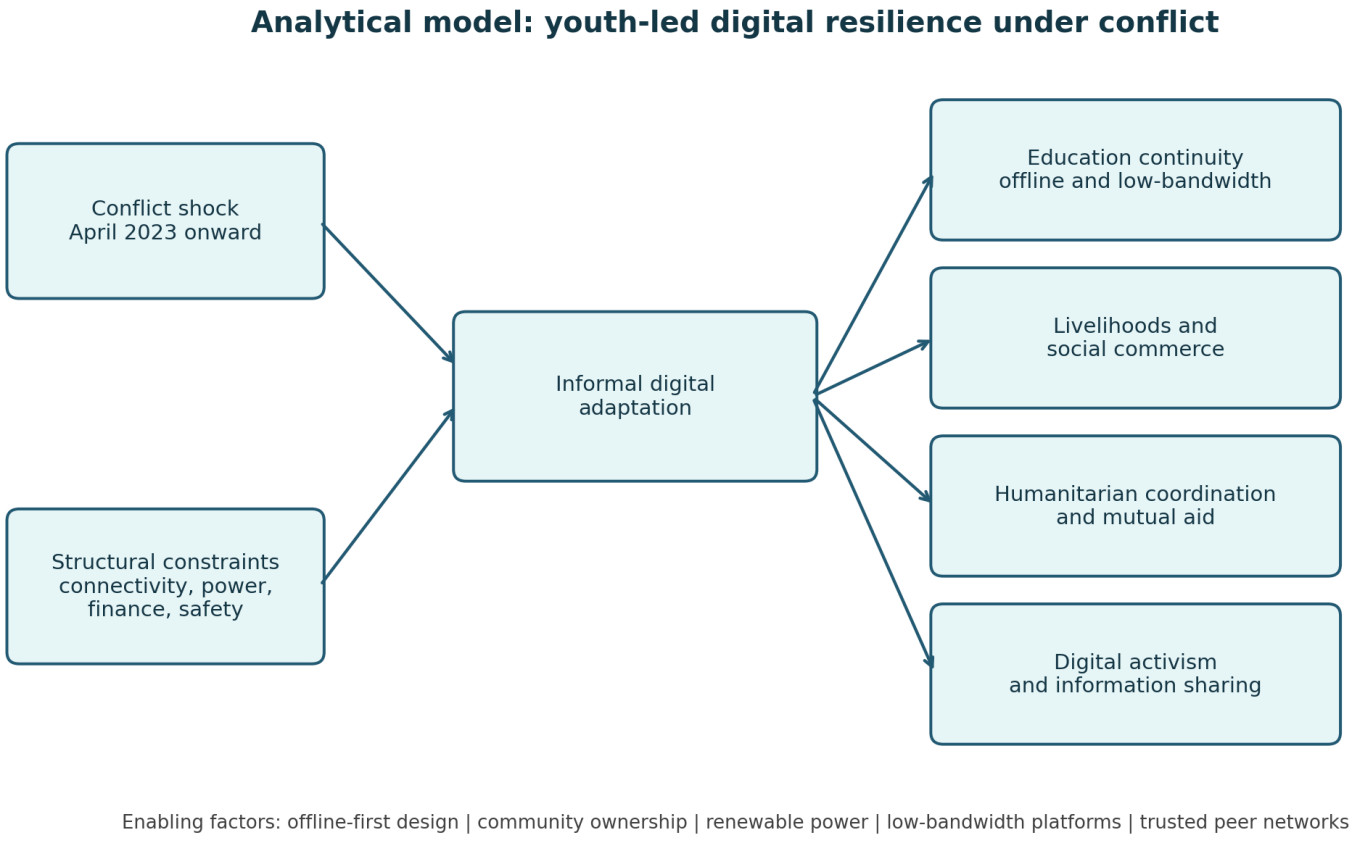


Figure 1

Conceptual framework for informal digital transformation under conflict.

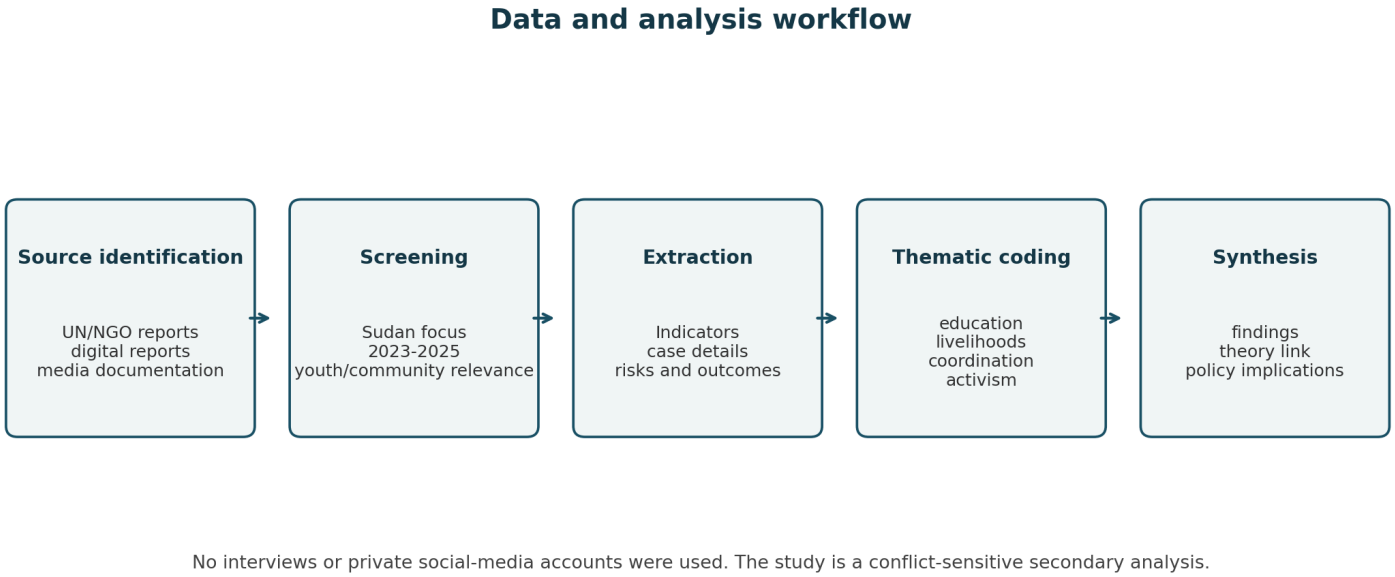
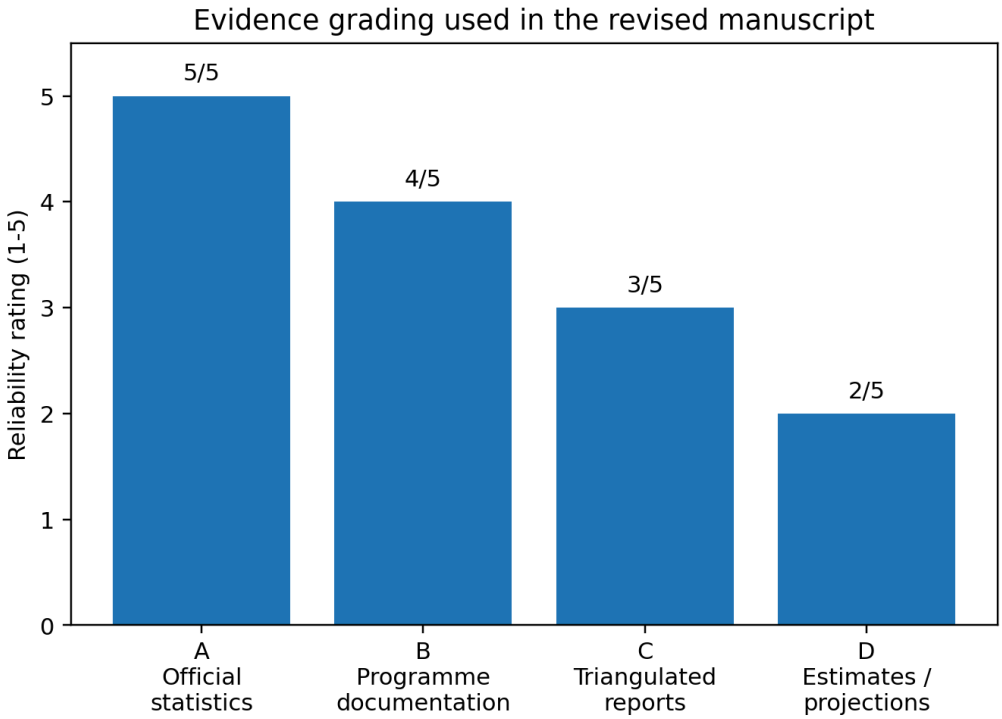


Figure 2

Data and analysis workflow used in the revised manuscript.



A = direct official statistics; B = programme reports; C = triangulated NGO/media evidence; D = clearly labelled estimates, not empirical findings.

Figure 3

Evidence grading diagram used to separate baseline data, cases, reports, and projections.

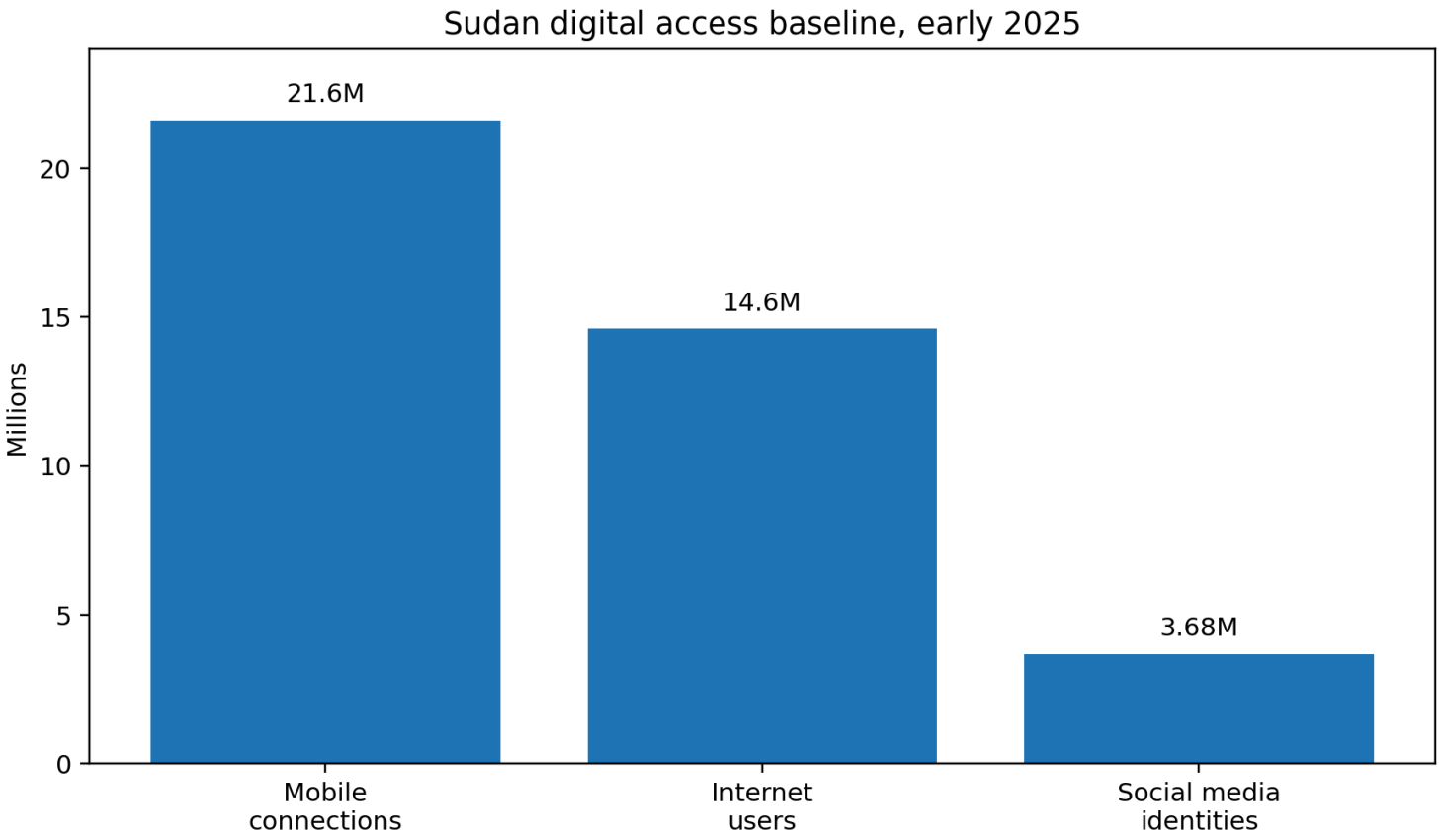


Figure 4

Sudan digital-access baseline, early 2025.