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An empirical assessment of the current state of mobile network deployment in Uganda

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Abstract:
This study reviews mobile network deployment in Uganda concerning the goals of Uganda Vision 2040. A survey of 109 telecommunications professionals from operators like MTN and Airtel reveals a moderate deployment level (mean = 2.61; SD = 1.11), limited by infrastructure issues. Despite 12,000 km of fiber optic cables, usage is restricted by routing inefficiencies and lack of infrastructure-sharing. The 3,517 mobile towers are inadequate for universal coverage, resulting in poor signal quality and hindering advancements like 5G. Data infrastructure appears stronger (mean = 3.88), but access remains predominantly mobile with minimal fixed-line use. A pronounced digital divide exists between rural and urban areas due to geographic and power supply issues, coupled with profit-driven deployments prioritizing urban centers. Investment in Very Small Aperture Terminal (VSAT) connectivity is deficient (mean = 2.44), adversely impacting remote populations. Overall, Uganda's mobile network faces significant infrastructure gaps, fragmented ownership, and insufficient policy enforcement, necessitating enhanced government efforts, infrastructure-sharing, rural expansion, and comprehensive digital strategies for equitable access.

Keywords : Deployment, Mobile network, Technologies, Uganda

1.0 Introduction

According to Arinze (2024), Mobile networks have fundamentally changed communication in Uganda, facilitating access to digital services across various socioeconomic and geographic divides. Aligned with Uganda Vision 2040, mobile technology is pivotal for digital transformation, with approximately 20 million Ugandans currently using smartphones (William,2024). For effective mobile network deployment, telecom companies need appropriate network architecture and technical capabilities, particularly concerning emerging technologies, security measures, and spectrum management. However, Uganda, like many other developing nations, confronts significant infrastructure challenges. Geographic factors, such as difficult terrain, rural isolation, and insufficient power supplies, hinder the establishment of robust networks and the

expansion of services to underserved regions (Arinze, 2024).

In Uganda, wireless networking technologies are essential for enhancing connectivity and socio-economic growth. A mixed strategy involving cellular, Wi-Fi, and satellite internet is proposed to strengthen the digital economy. The research paper by Arinze (2024) assessed wireless network implementation across telecommunications, education, healthcare, and agriculture, highlighting Wi-Fi's role in digital inclusion and job generation while addressing challenges like infrastructure and spectrum management. It also examined issues related to power supply, safety, staffing, and regulations, reviewing cellular networking growth from 2014 to 2024 and recommending hastening 5G deployment, improving access in rural areas, investing in IoT, and promoting government support through financial incentives and public awareness campaigns (Shabiluh et al.,2025).

Mobile network deployment in Uganda is rapidly evolving, highlighted by competitive 5G technology rollouts in urban areas by MTN Uganda and Airtel Uganda, despite a 4G infrastructure that covers over 96% of the population (William, 2024; Cariolle, & Carroll, 2022). Key developments include MTN's 660 5G sites and Airtel's 365 sites as of late 2025. Despite the expansion of a 56,000 km fiber optic backbone, a significant "usage gap" exists, with only 16.5 million to 18.2 million active internet users among 34 million to 51 million mobile subscribers, attributed to high device costs and insufficient digital skills. The government is promoting infrastructure sharing and lower-cost smartphones to bridge this digital divide (Motloung & Hofisi, 2025; Strusani & Houngbonon, 2020).

According to Ssekubugu(2025), mobile phones enhance global access to healthcare and public health services. However, challenges remain due to individuals frequently changing or dropping their phone numbers, impacting public health interventions like HIV follow-ups. A study in rural Uganda analyzed phone ownership trends from 2010 to 2020, revealing that ownership rose from 51.2% to 68.2%, although 30% of participants remained without phones. Women and younger individuals had lower ownership rates and were less likely to change numbers (Ssekubugu, 2025). Conversely, young people, those with lower socioeconomic status, and HIV-positive individuals were more likely to change numbers. A community peer system may be necessary to maintain contact with these vulnerable groups.

Wireless networking technologies have a major impact on socioeconomic development and connectivity in Uganda (Kituyi et al,2025). In order to address connectivity issues and promote a digital economy, Wi-Fi is critical for data transfer. To close the digital divide and promote innovation and education, an integrated strategy incorporating satellite internet, Wi-Fi, and cellular networks is recommended. Although there are still obstacles to overcome, such as infrastructure constraints and socioeconomic restrictions, wireless networks are being used in a variety of industries, including telecommunications, education, healthcare, and agriculture. Forecasts for future growth from 2014 to 2024 highlight the necessity of deploying 5G, improving rural connection, and making IoT investments. To assist this development, the government must improve cybersecurity, increase public awareness, and create updated teaching materials (Arinze, 2024).

According to Motloung & Hofisi, (2025), increased broadband access and digital inclusion are essential for national development, but the "digital divide" obstructs ICT adoption in rural and low-income areas of developing African countries. This study applies the spatially aware technology utilization model to examine the influences of demographic and socio-economic factors on this divide. It highlights the necessity of government interventions for equitable access to digital resources, especially for marginalized communities. The findings from the study of William,(2024) indicate that strategies should emphasize affordable ICT

access, infrastructure enhancement, and inclusive policies tailored to the needs of underserved regions to bridge gaps and mitigate further marginalization.

The study findings from related studies suggest that the primary barrier to satellite infrastructure deployment is the underfunding of Very Small Satellite Terminal (VSAT) connectivity, compounded by a lack of technical expertise in the satellite communication sector (william,2024). Additionally, Uganda's mobile network development faces challenges due to the duplication of optic fiber routes by multiple operators, leading to increased infrastructure maintenance costs and higher internet prices, thus limiting affordable access (Kituyi et al.,2025). The report advises the government to enforce its infrastructure sharing policy to eliminate duplication and to undertake expansion of the National Backbone Infrastructure (NBI) optic fiber nationwide for more accessible, cost-effective data infrastructure.

2.0 Problem Statement

Uganda is experiencing significant challenges in the deployment of mobile networks, particularly in rural areas that house over 80% of the population (Karama, 2024). The Uganda Vision 2040 emphasizes the importance of mobile and digital technologies for socio-economic development, yet current infrastructure is inadequate to meet connectivity objectives. Approximately 3,517 mobile towers exist, falling short of the necessary coverage for universal access(Sekitoleko et al., n.d). While about 12,000 km of optical fiber has been laid, inefficiencies have resulted in effective coverage of less than 2,100 km, thereby raising service costs and limiting user adoption. Service providers tend to favor urban areas, leaving rural users with persistent issues like poor signal quality and limited mobile data access. The lack of a comprehensive infrastructure-sharing framework contributes to duplicated investments and high operational costs, hindering network expansion (william, 2024). Despite policies aimed at promoting digital inclusion, a notable gap remains between the availability of infrastructure and access to services. This situation calls for a thorough empirical assessment of mobile network deployment in Uganda to identify bottlenecks and guide effective policy and investment strategies.

3.0 Methodology:

The study utilized a descriptive research design and cross-sectional survey methodology to collect quantitative data on mobile network deployment in Uganda. It targeted 150 professionals from key organizations, such as MTN and Airtel, focusing on both managerial and technical staff to gain insights into operational challenges and infrastructure gaps. This approach facilitated a comprehensive evaluation of the telecommunications landscape and the interplay between private sector reliance and infrastructure deficiencies.

Table 3.1: Sample size and Selection

	Category	Target Population	Sample Size	Sampling Technique
1.	**The Managerial network staff**			
	Network Engineer	29	21	Simple random sampling
	Chief Technology Officer (CTO),	10	07	Simple random sampling
	Network Administrator	16	12	Simple random sampling
	Quality Assurance (QA) Engineer	20	15	Simple random sampling

2.	**Technical staff**			
	Technical Support Specialist	45	33	Simple random sampling
	Network Operations Center (NOC) Technician	10	07	Simple random sampling
	Network Security Specialist	10	07	Simple random sampling
	Legal and Regulatory Affairs Specialist	10	07	Purposive sampling
	TOTAL	**150**	**109**	

Source: Research, (2024)

To determine sample size, the researcher applied Slovin's formula at a 0.05 significance level, resulting in 109 respondents from 150 experts. Simple random sampling was employed for Technical Support Specialists and Network Administrators, while purposive sampling targeted legal and regulatory affairs specialists. The final distribution comprised 31 respondents from Airtel, 24 from UETL, and 23 from MTN, ensuring a balanced analysis of technical deployment factors in Uganda's mobile network regulatory policies. The study employed a structured questionnaire with closed and open-ended questions, using a five-level Likert scale to evaluate network status and identify technological facilitators. Validity and reliability were confirmed through pilot testing. Data collection and analysis involved descriptive statistics with SPSS and Excel, revealing trends like underutilization of fiber optic capacity and a shortage of mobile towers, illustrated in cross-tabulation tables and figures.

4.0 Findings of the study

Table 4.1: State of mobile network deployment in Uganda

Statement	SA		A		NS		D		SD		Mean	S.D
	F	%	F	%	F	%	F	%	F	%		
There is wide fiber optic cable infrastructure connectivity in most areas of the country	8	7.3	25	22.9	19	17.4	38	34.9	19	17.4	2.68	1.22
There is enough towers to cater for full connectivity in the country	20	18.3	27	24.8	4	3.7	35	32.1	23	21.1	2.87	1.46
Many rural areas in a county have proper network coverage	7	6.4	48	42.2	5	4.6	33	30.3	18	16.5	2.92	1.28
There is data infrastructure growth and improvements in mobile infrastructure	28	25.7	55	50.5	13	11.9	11	10.1	2	1.8	3.88	0.97
There is growth in internet connectivity and usage in country	17	15.6	37	33.9	10	9.2	31	28.4	14	12.8	3.11	1.33
There is over reliance on the private sector when it comes to data infrastructure	19	17.4	43	39.0	0	0.0	25	22.9	22	20.2	3.01	1.43

There is enough financial investment in Very Small Aperture Terminal (VSAT) connectivity	4	3.7	23	21.1	19	17.4	34	31.2	29	26.6	2.44	1.20
Average Responses	**15**	**13.4**	**35**	**32.2**	**11**	**10.5**	**30**	**27.1**	**22**	**16.63**	**2.61**	**1.11**

Source: **Field study (2023/4)**

Key: Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree (D), Strongly Disagree (S.D) and Frequency (F)

4.2 Legend for Interpretation of Means

Scale	Mean Range	Response Mode	Interpretation
5	4.20 – 5.00	Strongly agree	Very high
4	3.40 – 4.20	Agree	High
3	2.60 – 3.40	Neither agree or disagree	Moderate
2	1.80 – 2.60	Disagree	Low
1	1.00 – 1.80	Strongly disagree	Very low

Source**: Field study (2023/4)**

The study assessed the state of mobile network deployment in Uganda using a five-point Likert scale. Overall, the findings show a moderately high level of deployment, with a mean score of 2.61 and a standard deviation of 1.11. Although this suggests some progress, the mean is only slightly above the low bracket, indicating that many respondents still perceive mobile network deployment as insufficient. The relatively high level of disagreement further reflects mixed opinions about the adequacy of network infrastructure across the country.

Regarding fiber optic infrastructure, most respondents disagreed that there is wide connectivity in most parts of the country. Despite some respondents agreeing, the majority expressed dissatisfaction, resulting in a moderately high mean score of 2.68. This indicates that fiber optic infrastructure remains limited and unevenly distributed, contributing to underutilized capacity and inefficiencies, especially due to fragmented management by private operators.

On the availability of mobile towers, the findings similarly reveal concerns. Although some respondents agreed that there are enough towers to ensure full connectivity, the majority disagreed, leading to a mean score of 2.87. The reported shortage of towers affects signal strength and service quality, limiting the country's ability to expand advanced technologies and achieve universal network coverage.

The results on rural network coverage present mixed views. While a slight majority agreed that many rural areas have proper network coverage, a significant proportion strongly disagreed. With a mean score of 2.92, the findings suggest that rural connectivity remains inconsistent. Geographic challenges, urban concentration of services, and unreliable power supply contribute to the persistent digital divide between urban and rural communities.

In contrast, respondents reported notable growth in data infrastructure and internet usage. With a high mean score of 3.88, the majority agreed that there have been improvements in mobile infrastructure and steady growth in internet connectivity, particularly driven by increased demand for digital services. However, mobile subscriptions dominate internet access, while fixed-line connections remain limited.

Finally, the study highlights structural and investment challenges. Most respondents agreed that data infrastructure ownership heavily relies on the private sector, leading to fragmented network management and limited resource sharing. Additionally, investment in

Very Small Aperture Terminal (VSAT) connectivity was rated low, with a mean of 2.44, indicating inadequate financial support for expanding connectivity in remote areas. Overall, while progress is evident, significant infrastructure, policy, and investment gaps remain.

The study indicates that mobile network deployment in Uganda is rated moderately high, with a mean score of 2.61 and a standard deviation of 1.11, reflecting a lack of consensus among experts about sufficient deployment. A major bottleneck is the insufficient fiber optic connectivity; despite 12,000 kilometers being laid, effective reach is below 2,100 kilometers due to poorly managed deployment by private operators, resulting in route duplication. This fragmentation leads to underutilization of fiber capacity as telecommunications companies avoid resource sharing, increasing operational costs and hampering the goal of widespread high-speed internet access.

Research findings indicate a critical shortage of mobile towers in Uganda, with a reported tower density mean score of 2.87. As of 2020, only 3,517 mobile towers were operational, supporting approximately 4,000 Base Transceiver Stations (BTS), which is insufficient for universal access. An additional 3,500 towers are needed, as currently, only 1,600 facilitate 3G networks. This lack of infrastructure leads to poor signal strength and degraded service quality, hampering advancements toward 5G and 6G technologies that require higher site density and faster transmission speeds.

The assessment of rural network coverage reveals a significant digital divide, with a mean score of 2.92 indicating inadequate connectivity in many rural areas, as reported by nearly 47% of respondents. This issue is driven by the concentration of telecommunications services in urban centers and the challenges posed by geographical factors and unreliable power supplies in rural regions. Consequently, there is a pressing need for alternative solutions like satellite backhaul and renewable energy-powered systems to address the connectivity needs of rural populations.

The study highlights positive developments in Uganda's data infrastructure and internet usage, with a mean score of 3.88 indicating growth in mobile infrastructure. By late 2020, there were over 20 million internet subscribers, averaging one connection for every two Ugandans, largely due to COVID-19-induced remote work. However, mobile access dominates with 99.86% of subscriptions, while fixed-line internet remains negligible. Investments in Very Small Aperture Terminal (VSAT) connectivity are minimal, scoring only 2.44, hampered by a lack of technical expertise and funding, affecting remote area connectivity.

4.0 Discussion of Results

The study highlights that mobile network deployment in Uganda is moderately high with a mean score of 2.61, but nearing a "low" classification due to a shortage of mobile towers as only 3,517 are available, about half of what is required for universal connectivity. This insufficiency results in poor signal quality and increased dropped calls. Additionally, only 1,600 stations support 3G, impeding the rollout of advanced technologies like 5G and 6G. The findings underscore the need to double tower capacity and enhance deployment strategies in challenging terrains.

A critical concern in Uganda's network assessment is the substantial underuse of fiber optic capacity, with only about 2,100 kilometers effectively utilized out of 12,000 kilometers installed. Disorganized deployment by private operators leads to route duplication and competition in profitable areas, especially greater Kampala, inhibiting infrastructure sharing. The prevailing profit-driven management in the private sector creates high capital costs for operators, resulting in expensive services for consumers. A robust policy framework for infrastructure sharing is essential to reduce duplication, improve efficiency of the national data backbone, and lower bandwidth costs across Uganda.

The research highlights a significant digital divide in Uganda, primarily favoring urban mobile users despite over 20 million internet

subscribers. With more than 80% of the population living in rural areas, connectivity issues persist due to economic unattractiveness for operators, low income levels, and high costs of powering base stations. The pandemic has prompted improvements in urban digital infrastructure, while rural residents remain isolated from essential services. Solutions propose shifting strategies towards utilizing unlicensed spectrum and deploying mesh networks to address the connectivity barriers outlined in Uganda Vision 2040.

5.0 Conclusion and Recommendation

5.1 Conclusion

The assessment of mobile network deployment in Uganda indicates a moderately high score of 2.61, revealing that infrastructure is insufficient to meet national demands. A critical issue is the shortage of physical towers, with only 3,517 in operation, while an additional 3,500 are necessary for comprehensive connectivity and to support advancements like 5G. Additionally, despite 12,000 km of optical fiber being installed, ineffective route management by private operators limits its practical reach to under 2,100 km, resulting in significant underutilization of fiber capacity due to isolated infrastructure management.

The study reveals a significant rural-urban digital divide in which over 80% of the population faces "spotty" or no coverage, driven by private operators' perceived lack of profitability. High rates of blocked and dropped calls are attributed to limited coverage and poor signal quality. The findings indicate that reliance on the private sector has led to an inflexible data infrastructure unable to adapt to technological changes. To meet Uganda Vision 2040's connectivity goals, a shift from isolated deployment strategies to a unified framework is necessary, focusing on infrastructure sharing, reducing spectrum prices, and adopting low-cost base station technologies in underserved areas.

Finally, the study identifies that mobile network deployment in Uganda faces structural, technical, and policy challenges, with a mean deployment level of 2.61 indicating inadequate infrastructure. Issues include insufficient mobile towers, underutilized fiber optic networks, and inefficient private sector practices, leading to poor service quality and limited coverage. The rural-urban digital divide persists, with rural areas lacking reliable connectivity.

5.2 Recommendations

To enhance mobile network deployment, Collaboration between the government and operators is essential for universal connectivity and advancing to 5G and 6G through increasing the ICT budget and promoting public-private partnerships will improve the fiber optic backbone in underserved areas, lower deployment costs, and provide affordable power to remote locations.

The government should implement an infrastructure sharing policy to end duplication, increase investment in rural ICT backbone expansion, and incentivize the deployment of more mobile towers to bridge the digital divide.

Uganda's 12,000 km optical fiber network is largely underutilized, with only about 2,100 km effectively covered due to duplication. To improve efficiency and reduce costs, a robust policy for infrastructure sharing is essential, necessitating government regulation to encourage collaboration among private sector operators regarding masts, cell sites, and fiber routes.

Strategies to improve access to digital services in rural areas affected by the digital divide involve implementing satellite backhaul and wireless mesh networks. The government should promote the use of unlicensed spectrum and support ad hoc networks, focusing on fair pricing and shared facilities for vital services like e-health and mobile money.

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