**University of Pardubice**

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# COMPARISON OF COUNTRIES IN AFRICA FROM THE POINT OF VIEW OF ICT UTILIZATION DEVELOPMENT

**Master Thesis**

**2025**

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**ANNOTATION**

This master's thesis provides a comparative analysis of Information and Communication Technology (ICT) utilisation across African countries. The mixed-methods approach is clear: ICT development indicators such as mobile and fixed broadband subscriptions, internet usage, and access to electricity are evaluated. Quantitative methods, including descriptive statistics, correlation analysis, cluster analysis, and regression modelling, were applied to assess structural patterns, while qualitative analysis explored national policy frameworks and strategic gaps. The findings reveal deep regional disparities in digital inclusion and infrastructure. The results conclusively show that the thesis presents seven evidence-based policy recommendations to support inclusive and sustainable ICT development.

**KEY WORDS**

ICT development in Africa, digital divide, internet access in Africa, broadband infrastructure in Africa, digital inclusion

**ANOTACE**

Tato diplomová práce poskytuje srovnávací analýzu využití informačních a komunikačních technologií (IKT) v afrických zemích. Přístup smíšených metod je jasný: jsou hodnoceny ukazatele rozvoje IKT, jako jsou předplatné mobilního a pevného širokopásmového připojení, používání internetu a přístup k elektřině. Kvantitativní metody, včetně deskriptivní statistiky, korelační analýzy, shlukové analýzy a regresního modelování, byly použity k posouzení strukturálních vzorců, zatímco kvalitativní analýza zkoumala národní politické rámce a strategické mezery. Zjištění odhalují hluboké regionální rozdíly v digitální inkluzi a infrastruktuře. Výsledky přesvědčivě ukazují, že práce představuje sedm politických doporučení založených na důkazech na podporu inkluzivního a udržitelného rozvoje IKT.

**KLÍČOVÁ SLOVA**

rozvoj informačních a komunikačních technologií (IKT) v Africe, digitální propast, přístup k internetu v Africe, infrastruktura širokopásmového připojení v Africe, digitální inkluze

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# LIST OF ACRONYMS AND ABBREVIATIONS

2G - Second Generation (mobile technology)
3G - Third Generation (mobile technology)
4G - Fourth Generation (mobile technology)
5G - Fifth Generation (mobile technology)
AFCFTA - African Continental Free Trade Area
AI - Artificial Intelligence
AO - Angola
AU - African Union
BF - Burkina Faso

BI - Burundi
BJ - Benin
BW - Botswana
CAB - Central African Backbone
CD - Democratic Republic of the Congo
CF - Central African Republic
CG - Republic of the Congo
CI - Ivory Coast (Côte d'Ivoire)
CM - Cameroon
COVID-19 - Coronavirus disease 2019
CV - Cape Verde
DE4A - Digital Economy for Africa
DJ - Djibouti
DSL - Digital Subscriber Line
DZ - Algeria
ECOWAS - Economic Community of West African States
EG - Egypt
ER - Eritrea
ESSP - Education Sector Strategic Plan
ET - Ethiopia
FDI - Foreign Direct Investment
GA - Gabon
GB – Gigabyte
GDP - Gross Domestic Product
GH - Ghana
GM - Gambia
GN - Guinea
GQ - Equatorial Guinea
GSMA - Group Special Mobile Association
GW - Guinea-Bissau
HCI - Human Capital Index
HIPSSA - Harmonisation of ICT Policies in Sub-Saharan Africa
ICT - Information and Communication Technology
ILO - International Labour Organisation
ITU - International Telecommunication Union
KE - Kenya
KM - Comoros
LEO - Low-Earth Orbit
LMICs - Low- and Middle-Income Countries
LR - Liberia

LS - Lesotho
LTE - Long-Term Evolution
LY - Libya
MA - Morocco
MBPS - Megabits per second
MG - Madagascar
ML - Mali
MR - Mauritania
MU - Mauritius
MW - Malawi
MZ - Mozambique
N/A - Not Applicable
NA - Namibia
NE - Niger
NG - Nigeria
NGOs-Non-Governmental Organizations
PIDA - Program for Infrastructure Development in Africa
PPPs - Public-private partnerships
PRIDA - Policy and Regulatory Initiative for Digital Africa
R&D - Research and Development
RECs - Regional Economic Communities
RW - Rwanda
SC - Seychelles
SD - Sudan
SIM - Subscriber Identity Module
SL - Sierra Leone
SMEs - Small and Medium-sized Enterprises
SN - Senegal
SO - Somalia
SS - South Sudan
ST - Sao Tome and Principe
STISA-2024 - Science, Technology, and Innovation Strategy for Africa 2024
SZ - Eswatini (Swaziland)
TD - Chad
TG - Togo
TN - Tunisia
TVET - Technical and Vocational Education and Training
TZ - Tanzania
UG - Uganda
UN - United Nations

WDI - World Development Indicators
ZA - South Africa
ZM - Zambia
ZW – Zimbabwe

# 1 INTRODUCTION

It is universally acknowledged that Information and Communication Technology (ICT) serves as a critical catalyst for socio-economic transformation. In the African context, ICT has emerged as a strategic enabler for development, particularly as the continent seeks integration into the global digital economy. Despite the rapid growth in mobile connectivity and digital platforms [1]. Africa continues to face stark disparities in ICT access, usage, and infrastructure [2]. The digital divide, driven by economic, geographic, and policy constraints, remains a major impediment to inclusive growth [3].

The study used an explanatory sequential mixed methods design to achieve this. It integrates quantitative data from international databases, such as the ITU and World Bank, with qualitative analysis of national ICT policies. A quantitative approach was used, encompassing descriptive statistics, cluster analysis, and regression modelling, to assess pivotal indicators including mobile and fixed broadband subscriptions, internet usage, Gross Domestic Product (GDP) per capita, and literacy rates. Clustering techniques were employed to identify distinct country groupings based on ICT readiness. Regression analysis was then used to evaluate the significance of infrastructure and socioeconomic variables in predicting digital adoption [4].

The findings clearly show that countries can be divided into three groups based on their ICT adoption levels, clustered as low, medium, and high. These findings highlight the structural and policy-driven gaps that exist [1]. Mauritius and South Africa lead in digital access and human capital development. Chad and South Sudan are hindered by infrastructural deficits and affordability barriers [2]. These disparities indicate the urgent need for targeted policy interventions that address both technological and socio-economic dimensions [3] and [5].

# 2 LITERATURE REVIEW

## 2.1 Overview of ICT Development in Africa

Developing Information and Communication Technology in Africa is a significant opportunity for economic growth and social development across the continent. As Africa has been struggling to integrate into the global digital economy, the expansion of ICT infrastructure is critical. [6]. This chapter examines the current landscape of ICT in almost all African countries, highlighting achievements and challenges. The rapid growth of ICT across Africa in the late 2000s and early 2010s has significantly impacted social and economic development. The focus has shifted from improving information flows to leveraging ICT for transformative opportunities [7].

According to [8] Their study argues that Investment in ICT, mobile phones, and research and development are significant for economic growth. Their findings indicate that ICT diffusion increases the share of R&D and human capital formation and has an indirect positive impact on economic growth [6]. Similarly, ICT has become the cornerstone of social, financial, and institutional development worldwide [9]. Research has shown its role in increasing productivity, reducing communication costs, stimulating innovation, and closing development gaps, especially in regions with low network access [12].

Over the past two decades, Africa has witnessed remarkable mobile telephony and internet connectivity growth. Mobile phone penetration has surged, with over 60% of the population in 2024 now having access to mobile services [13]. This growth has enabled innovative applications, such as mobile banking and e-commerce, which have transformed business practices and improved access to services in many African countries [14]. This growth has enabled innovative applications, such as mobile banking and e-commerce, which have transformed business practices and improved access to services in many African subregions [15]. However, despite this progress, internet access remains limited, with about 75% of the population still offline, according to the ICA report.

## 2.2 ICT Infrastructure Connectivity in Africa

The ICT infrastructure in Africa, the heart of the 21st-century data infrastructure, is the ability to connect to the Internet, and it is a system of interconnected computers, and the backbone being the network that connects the parts [10]. Internet usage in Africa has increased but is lower than the global average due to infrastructure and economic constraints [22]. ICTs support businesses by using Internet technology, driving e-commerce growth and economic growth in this digital economy based on new markets, businesses, and goods and services [3].

ICT infrastructure plays a critical role in promoting inclusive growth in Africa, but there are significant disparities across the continent According to their paper that investment in ICT infrastructure has a positive and significant impact on economic development, with an increase in ICT investment boosting inclusive growth by 0.4% to 0.7% on average [4]. However, regional disparities persist as urban areas benefit more from ICT advances, while many rural communities remain underserved due to inadequate cross-border connectivity and infrastructure deficits. The lack of reliable electricity further hampers ICT expansion, especially in remote areas with inconsistent electricity supply. In addition, the high cost of ICT services in some African countries limits affordability and accessibility for marginalised populations, exacerbating the digital divide [12].

Despite these challenges, ICT infrastructure contributes to economic development by reducing transaction costs, improving productivity, and expanding market access. It also supports key sectors such as financial services, where mobile banking solutions such as M-Pesa in Kenya have transformed financial inclusion. In addition, digitalisation can address inefficiencies in labour markets by reducing job search costs and facilitating job matching. To improve ICT infrastructure and maximise its benefits, Nchake and Shuaibu [19] suggest that governments should expand broadband access through public-private partnerships, especially in rural areas. Strengthening policy frameworks to reduce licensing costs and improve access to digital services is also critical to ensure that ICT infrastructure supports equitable and sustainable development in all African countries [13] .

**The Role of Government Policies and Initiatives:** Various governments are implementing policies aimed at fostering ICT growth. The African Union's Agenda 2063 emphasises the importance of ICT as a driver for economic transformation and social progress [16]. Governments are increasingly investing in ICT to ignite economic participation, uplift communities, and foster abundant employment opportunities. For example, the Central African Backbone (CAB) project has the goal of improving broadband connectivity throughout Central Africa [4].

Government policies and initiatives play a pivotal role in shaping ICT development across Africa, with distinct approaches in East and West Africa reflecting regional priorities and challenges. These frameworks address infrastructure gaps, digital inclusion, and economic transformation through strategic partnerships and regulatory reforms [14].

Government policies in East and West Africa demonstrate adaptive strategies for ICT development that balance national priorities with regional cooperation. Kenya's infrastructure Master Plans and Ethiopia's privatisation efforts Highlight East Africa's focus on scalable, investor-friendly models. Meanwhile, West Africa's Economic Community of West African States (ECOWAS) initiatives and World Bank partnerships underscore the importance of cross-border coordination. Sustained success depends on addressing

affordability, improving rural infrastructure, and strengthening policy enforcement to bridge the digital divide [14].

**Investment in Infrastructure:** Investment in ICT infrastructure is a cornerstone of Africa's digital transformation, with significant implications for economic growth, social development, and global competitiveness [15]. Over the past decade, the continent has witnessed accelerated efforts to expand ICT infrastructure, including the deployment of fibre optic networks, mobile broadband services, and satellite technologies [16]. These investments are driven by a combination of private-sector initiatives, international partnerships, and strategic policy reforms. However, despite notable progress, challenges such as rural-urban disparities, monopolistic market structures, and policy fragmentation persist, underscoring the need for continued investment and coordinated action to bridge the digital divide [4].

Africa has made significant strides in expanding its ICT infrastructure, particularly in deploying fibre optic networks and mobile broadband services. For instance, Mauritania deployed over 1,700 kilometres of fibre optic cable between 2021 and 2022, significantly enhancing internet connectivity and data transmission capabilities [17]. Similar projects have been undertaken across the continent, with countries like Kenya, Nigeria, and South Africa leading the way in fibre optic network expansion. These investments have improved internet speeds and reliability and laid the foundation for the development of advanced digital services, such as cloud computing, e-government platforms, and smart city initiatives [4].

The rapid growth of mobile broadband services has further complemented these efforts, enabling millions of Africans to access the Internet for the first time. Mobile network operators have played a pivotal role in this expansion, leveraging their infrastructure to provide affordable and accessible connectivity [17]. As a result, mobile broadband penetration has increased radically, particularly in urban areas, where demand for high-speed internet is highest.

The acceleration of ICT infrastructure investment in Africa can be attributed to several key factors. First, private sector participation has been instrumental in driving innovation and expanding access to digital services. Telecommunications companies, technology firms, and startups have invested heavily in network infrastructure, data centres, and digital platforms, creating a vibrant ecosystem for ICT development. For example, multinational corporations like Google and Facebook have launched initiatives such as undersea fibre-optic cables and satellite internet projects to enhance connectivity in underserved regions [19].

Second, international partnerships have played a crucial role in mobilising resources and expertise for ICT infrastructure projects. Chinese investments have been significant, with companies like Huawei and Zhongxing Telecommunication Equipment (ZTE) contributing to the construction of fibre optic networks and mobile broadband infrastructure across the continent [6]. Additionally, multilateral organisations and development finance institutions

have provided funding and technical assistance to support ICT initiatives, particularly in low-income countries [19].

Third, strategic policy reforms have created an enabling environment for ICT investment. Governments across Africa have implemented measures to reduce market structure constraints, promote competition, and attract private sector participation. For instance, regulatory reforms aimed at addressing monopolistic practices and lowering barriers to entry have improved the affordability and accessibility of ICT services [13]. These policies have not only stimulated investment but have also fostered innovation and entrepreneurship in the ICT sector [7].

Despite these advancements, significant challenges remain in achieving equitable ICT infrastructure development across Africa. One of the most pressing issues is the rural-urban digital divide, which limits access to digital services in remote and underserved areas [20]. While urban centers have benefited from extensive fiber optic networks and high-speed internet, rural areas often lack basic connectivity infrastructure, perpetuating inequalities and hindering inclusive development. Another challenge is the persistence of monopolistic market structures in some countries, which restrict competition and inflate the cost of ICT services [16].

In such environments, dominant players may prioritise profit over accessibility, limiting the reach of digital technologies and exacerbating the digital divide. Addressing these issues requires targeted policy interventions, such as the promotion of open access networks and the enforcement of antitrust regulations, to ensure that ICT services are affordable and accessible to all. Furthermore, the lack of policy harmonisation across regions poses a barrier to seamless connectivity and cross-border collaboration [21]. Inconsistent regulatory frameworks and fragmented infrastructure planning can hinder the development of regional ICT networks, limiting the potential for economies of scale and knowledge-sharing [22]. Addressing these challenges requires greater coordination among African nations, as well as the adoption of harmonised policies and standards to facilitate regional integration [23].

Strategic investments in ICT infrastructure are critical to unlocking Africa's $712 billion digital economy potential [6]. By expanding access to high-speed internet, fostering innovation, and enabling the development of digital services, these investments can drive economic growth, create jobs, and improve quality of life [24]. However, realising this potential requires a holistic approach that addresses both infrastructural and policy barriers [21]. Public-Private Partnerships (PPPs) can play a higher role in mobilising resources and expertise for ICT infrastructure projects, particularly in underserved areas [25]. Governments can also leverage international partnerships and development finance to fund large-scale initiatives, such as national broadband networks and digital literacy programs [26]. Additionally, policy reforms aimed at promoting competition, reducing costs, and enhancing

regulatory coherence are essential to creating an enabling environment for ICT investment [10].

**Digital Transformation Acceleration in Africa**

The COVID-19 pandemic has catalysed digital transformation across Africa, accelerating the adoption of ICT in key sectors such as agriculture, education, healthcare, and finance. This shift has underscored the critical role of ICT in enhancing economic resilience, fostering job creation, and driving inclusive growth [27]. African governments, recognising the transformative potential of ICT, have implemented various policies and initiatives to support digital transformation and infrastructure development. However, despite significant progress, challenges such as infrastructure limitations, high costs, and low digital literacy persist, necessitating further efforts to maximise the benefits of ICT for sustainable development [20].

In the education sector, for instance, during the COVID-19 pandemic, the closure of schools prompted the rapid adoption of e-learning platforms, enabling millions of students to continue their education remotely. Similarly, in agriculture, digital tools such as mobile-based advisory services and online marketplaces have empowered farmers to access real-time information, improve productivity, and connect with buyers [27]. These innovations have not only mitigated the impact of the pandemic but have also demonstrated the potential of ICT to drive long-term transformation [20].

Recognising ICT as a critical driver of inclusive growth, many African governments have implemented policies and initiatives to support digital transformation. The African Union (AU) has played a pivotal role in this regard, launching the Digital Transformation Strategy for Africa (2020-2030). This strategy aims to promote digital inclusion by expanding access to ICT services, refining regulatory policies, and increasing investment in ICT infrastructure. Key objectives include reducing licensing fees, streamlining regulations, and fostering innovation to improve the affordability and accessibility of digital services [8].

At the regional level, several infrastructure projects have been launched to enhance digital connectivity. For example, the Central African Backbone, the East African Broadband Network, and the ECOWAS fibre network aim to improve cross-border connectivity and facilitate regional integration. These initiatives are complemented by national efforts to promote financial inclusion through mobile payment platforms, such as Kenya's M-Pesa and Uganda's mTrac, which have revolutionised access to financial services for millions of unbanked individuals [8].

Additionally, e-governance measures have been introduced to strengthen transparency, accountability, and cybersecurity, further underscoring the transformative potential of ICT [28]. The pandemic also highlighted the importance of ICT in enhancing economic resilience and job creation. As lockdowns and social distancing measures disrupted traditional business models, digital platforms emerged as critical enablers of economic activity. E-commerce, for

example, experienced unprecedented growth, providing Small and Medium-sized Enterprises (SMEs) with new opportunities to reach customers and sustain operations [17].

These technologies are being leveraged to address development challenges and create new growth opportunities. For instance, AI-powered platforms are being used to optimise agricultural practices, while blockchain technology is enhancing transparency in supply chains and financial transactions [22]. The rise of fintech innovations has been particularly transformative, enabling millions of Africans to access financial services for the first time. Mobile money platforms have played a crucial role in promoting financial inclusion, with over 500 million mobile money accounts registered in Sub-Saharan Africa as of 2023 [29]. These innovations highlight the potential of ICT to drive inclusive growth and reduce poverty [19].

Infrastructure limitations, particularly in rural and underserved areas, continue to hinder access to digital services [30]. High costs of internet access and devices further exacerbate the digital divide, limiting the ability of low-income populations to benefit from ICT advancements [31]. Additionally, low levels of digital literacy pose a barrier to the effective use of digital tools, particularly among older adults and marginalised groups. Addressing these challenges requires a multi-faceted approach, including increased investment in ICT infrastructure, policy adjustments to reduce costs, and initiatives to enhance digital literacy [4]. To fully harness the potential of ICT for inclusive economic development, African nations must adopt a holistic approach that addresses both infrastructural and socio-economic barriers. This includes expanding the ICT infrastructure and reducing the cost of internet access [14].

## 2.3 The Economic and Social Impact of ICT in Africa

The relationship between ICT and socio-economic development is increasingly recognised as a crucial driver of competitiveness and economic growth, particularly in African countries. As nations strive to integrate into the global digital economy, ICT infrastructure and digital adoption have become essential in enhancing productivity, fostering innovation, and improving overall economic performance [32]. The rapid expansion of mobile and broadband networks across Africa has facilitated access to financial services, e-commerce, and digital education, reducing traditional barriers to economic participation. However, the extent to which ICT drives economic transformation depends on factors such as infrastructure development, affordability, and regulatory frameworks [10].

ICT is a strong influence in boosting economic performance by improving efficiency across various sectors, including agriculture, Education, and Transportation. Digital technologies enable farmers to access market prices, weather forecasts, and financial services, thereby increasing agricultural productivity and reducing post-harvest losses [33]. Moreover, the

integration of ICT in industrial processes enhances efficiency, reduces production costs, and fosters innovation, making local industries more competitive in the global market [34].

These advancements contribute to higher economic output, job creation, and improved living standards. Beyond economic growth, ICT has profound socio-economic impacts by promoting financial inclusion, digital literacy, and access to essential services [18]. Mobile banking platforms like M-Pesa in Kenya have revolutionised financial transactions, providing banking access to previously unbanked populations [35]. Digital education initiatives and online learning platforms have expanded access to knowledge, bridging gaps in traditional education systems and preparing the workforce for a digital economy. Furthermore, ICT-driven governance initiatives, such as e-governance and digital public services, enhance transparency, reduce bureaucratic inefficiencies, and foster citizen engagement. Despite these benefits, challenges such as the digital divide, affordability issues, and weak ICT regulations must be addressed to ensure that ICT's transformative potential is fully realised across African economies [6].

### 2.3.1 GDP Growth

ICT has emerged as a critical driver of economic growth, transforming industries, enhancing productivity, and fostering innovation [36]. By enabling businesses to streamline operations, reduce costs, and access global markets, ICT provides a competitive advantage that is essential for sustainable development. This section explores the multifaceted role of ICT in economic growth, focusing on its impact on productivity, employment, financial inclusion, regional trade, and Gross Domestic Product (GDP) growth. It also highlights the challenges and opportunities associated with ICT adoption, particularly in Africa [37].

#### ICT as a Driver of Competitive Advantage

ICT is a key enabler of competitive advantage. in the world economy, countries that use ICT in their economic frameworks have gained a comparative advantage by optimising production, reducing costs, and innovating. Comparative advantage, which refers to a country's ability to produce goods and services more efficiently than others, is significantly enhanced by ICT adoption. Firms that leverage ICT tools grow faster, achieve higher profitability, and are better positioned to compete in global markets [23]. For instance, digital technologies enable businesses to automate processes, analyse data for informed decision-making, and improve supply chain efficiency, all of which contribute to increased productivity and competitiveness [9].

ICT plays a critical role in research and development (R&D), as advanced systems support innovation and technology-driven industries, ensuring sustainable growth. Finally, ICT strengthens supply chain management by optimising logistics, reducing delays, and improving efficiency in trade and manufacturing [38].

### ICT and GDP Growth

As I observed, many research studies have shown that ICT and GDP have a strongly positive relationship, indicating sustainable economic development. Countries that invest in ICT infrastructure, such as broadband networks and digital skills training, tend to experience significant improvements in economic performance. For example, research shows that high levels of ICT development contribute to value creation, which directly influences GDP growth [23], [24]. In Africa, ICT has become a key driver of economic transformation. Mobile technology and fintech innovations have expanded financial inclusion, integrating previously unbanked populations into the formal economy and boosting GDP. For instance, mobile money platforms like M-Pesa in Kenya have not only transformed financial transactions but also stimulated economic activity by enabling savings, loans, and payments for millions of people [11].

### ICT's Impact on Employment

The adoption of ICT stimulates job creation by fostering new industries and enhancing existing ones. Digital technologies facilitate the emergence of innovative business models, creating employment opportunities across various sectors. The growth of ICT industries, including software development, telecommunications, and IT services, has generated millions of jobs worldwide [39].

In Africa, tech hubs such as Silicon Savannah in Kenya have provided employment opportunities for software engineers, data analysts, and digital entrepreneurs. Moreover, ICT enables digital entrepreneurship, particularly through e-commerce platforms and fintech solutions. Companies like Jumia and M-Pesa have not only revolutionised financial transactions but also created jobs in logistics, digital marketing, and customer support. These platforms allow entrepreneurs to start businesses with minimal capital investment, further driving job creation and economic growth [35].

### Enhancing Productivity and Business Efficiency

ICT tools have revolutionised business operations by streamlining processes, reducing costs, and improving service delivery. For example, mobile technologies have transformed sectors like agriculture, enabling farmers to access real-time market information and weather forecasts, which enhance decision-making and productivity [40]. Similarly, automation, big data analytics, and digital communications have improved efficiency across industries, maximisings output and contributing to economic progress [13]. Advances in financial technology (fintech) have also transformed financial management and payment processes. Mobile banking, AI-powered accounting tools, and digital payment systems simplify transactions, enhance security, and mitigate the risk of financial fraud. Platforms such as PayPal, M-Pesa, Telebirr, and Stripe enable faster transactions, improved cash flow management, and greater financial stability for businesses [14].

### Boosting Regional Trade and Global Integration

Improved ICT infrastructure facilitates better communication and coordination, enabling African countries to integrate more effectively into global markets. This integration is vital for attracting Foreign Direct Investment (FDI) and enhancing trade relationships within the continent. After 2000, Africa became the third fastest-growing region in the world, largely due to increased domestic investment in the services sector, where ICT plays a pivotal role [24]. Research examining 44 African countries from 1990 to 2010 indicates that investments in telecommunications yield increasing returns.

## 2.3.2 The Role of ICT in Social Development

ICT has emerged as a transformative force in social development, driving innovation, fostering entrepreneurship, and enhancing access to essential services, including education, healthcare, and financial inclusion. By creating an enabling environment for startups, expanding e-commerce opportunities, and bridging the digital divide, ICT empowers individuals and communities, particularly in underserved and marginalised areas. This section explores the multifaceted role of ICT in social development, with a focus on its impact on innovation, entrepreneurship, and access to critical services [10].

### Driving Innovation and Entrepreneurship

ICT has become a powerful enabler of innovation and entrepreneurship, providing individuals and businesses with the tools to develop new products, services, and business models [34]. By fostering a culture of creativity, problem-solving, and collaboration, ICT empowers startups and small businesses to address local challenges, scale their operations, and compete in global markets. This section examines how ICT supports innovation ecosystems and entrepreneurial activities, particularly in developing regions [41].

### E-commerce Growth

The rise of e-commerce platforms has revolutionised the way businesses operate, particularly in developing regions, by opening new markets and enabling businesses to reach customers beyond their localities. Platforms such as Jumia, Konga, and Takealot have transformed the retail landscape, allowing businesses to expand their customer base, increase sales, and improve profitability. This growth has stimulated job creation in related sectors, such as logistics, digital marketing, and customer service, contributing to economic development and poverty reduction. E-commerce also empowers SMEs by providing them with affordable access to global markets [27]. By leveraging digital platforms, SMEs can overcome traditional barriers such as limited physical infrastructure, high operational costs, and geographic isolation. For example, artisans and farmers in rural areas can use e-commerce platforms. This democratisation of market access is particularly significant in rural areas,

where e-commerce can bridge the gap between producers and consumers, fostering inclusive economic growth [42].

By expanding market access and fostering financial inclusion, e-commerce contributes to poverty alleviation, economic empowerment, and social development [40].

## 2.4 Challenges of ICT Development in Africa

The integration of ICT into socio-economic frameworks has the potential to drive transformative change in Africa. However, the region faces significant challenges that hinder the widespread adoption and effective utilisation of ICT. These challenges include infrastructure gaps, high costs of internet access, digital illiteracy, skills shortages, and disparities in investment [33]. Addressing these barriers is critical to unlocking the full potential of ICT for economic growth, social development, and digital inclusion. This section examines the key challenges of ICT development in Africa, drawing on empirical evidence and existing literature to provide a comprehensive analysis [28].

**Infrastructure Gaps**

One of the most significant barriers to ICT development in Africa is the inadequate state of digital infrastructure, particularly in rural and remote areas. Despite progress in expanding mobile broadband networks, many regions still lack reliable and affordable internet connectivity. According to the International Telecommunication Union (ITU), nearly 25% of Africa's population who live in rural areas lacked internet access between 2020 and 2021, severely limiting digital opportunities for millions of people[10]. Rural areas, in particular, face serious connectivity challenges due to the high cost of infrastructure deployment, low population density, and limited economic incentives for private sector investment [18].

The rapid expansion of mobile broadband subscriptions has positioned mobile networks as the primary gateway to Internet access in Africa [10]. As the continent leapfrogs traditional fixed-line infrastructure in favour of mobile technologies, mobile broadband has become a critical metric for assessing digital inclusion and ICT adoption. However, the uneven distribution of mobile network coverage exacerbates the digital divide, with urban areas benefiting disproportionately from connectivity compared to rural regions. For instance, while urban centres often enjoy high-speed 4G and 5G networks, rural areas may rely on slower and less reliable 2G or 3G connections, if they are connected at all [43].

To address these infrastructure gaps, governments and stakeholders must prioritise investments in expanding ICT infrastructure to underserved areas. This includes deploying fibre-optic cables, building more cell towers, and leveraging innovative solutions such as satellite internet and low-Earth Orbit (LEO) satellites [44]. Additionally, PPPs can play a crucial role in mobilising resources and expertise to bridge the infrastructure divide. Policy reforms that incentivise private sector investment in rural connectivity, such as tax breaks

and regulatory flexibility, are also essential for achieving universal access to digital services [25].

## 2.5 ICT in Education and Digital Literacy

The integration of ICT into the education sector has emerged as a pivotal driver of pedagogical innovation, access to quality education, and workforce readiness in Africa. ICT has the potential to transform teaching and learning processes, bridge educational inequities, and equip students with the digital skills needed to thrive in the 21st-century economy. However, progress in ICT integration remains uneven across the continent, shaped by disparities in infrastructure, policy frameworks, and socio-economic conditions [7]. This section examines the role of ICT in education across Africa, highlighting regional and national comparisons, success stories, persistent challenges, and the impact of ICT on learning outcomes.

### 2.5.1 The Role of ICT in Education

According to [43], ICT plays a critical role in enhancing the teaching and learning process at all levels of education. It facilitates the acquisition of knowledge, promotes interaction. In Africa, where educational systems often face challenges such as overcrowded classrooms, inadequate teaching materials, and teacher shortages, ICT offers a transformative opportunity to improve the quality and accessibility of education [29]. For example, in Nigeria, the use of ICT in education is still in its infancy. Despite being one of Africa's largest economies, Nigeria's educational system struggles to meet global standards due to limited ICT integration. To address this gap, there is a pressing need to incorporate ICT tools and platforms that facilitate knowledge acquisition both within and outside the classroom. This includes leveraging digital learning resources, online courses, and interactive teaching methods to enhance student engagement and learning outcomes [7].

### 2.5.2 Regional and National Comparisons

The adoption and impact of ICT in education vary significantly across Africa, reflecting differences in infrastructure development, policy priorities, and socio-economic conditions. This section provides a comparative analysis of ICT integration in education across high-performing countries, emerging adopters, and lagging countries.

A. **High-Performing Countries:** The Countries with the best education system in Africa are Seychelles, South Africa, Kenya, Namibia, Tunisia, Algeria, Cape Verde, Nigeria, Mauritius, Botswana, Egypt, and Ghana**.** Let's see some countries below [45]**.**

**Mauritius:** Mauritius stands out as a leader in ICT-education integration in Africa. The government of this country aims to develop higher education reform is currently at the pre-primary and Secondary levels, with a tertiary enrolment rate of 17% to 30%. The government's national strategy is to develop the country's knowledge hub [46]. They provided free transportation to all the students to encourage and support the students [45].

**South Africa:** South Africa's Education system is very developed, and their government is investing their budget, estimated expenditure of 18% to improve the country's standard of education system [45].The mission of the Department of Higher Education and Training is to cultivate competent, educated, and skilled citizens who possess the necessary skills to compete in a sustainable, diversified, and knowledge-intensive global economy, thereby aligning with the development objectives of our nation [47].

**Kenya:** Kenya, a nation situated in the eastern region of the African continent, has demonstrated a commitment to educational advancement and development. This commitment is evidenced by its ranking as the 95th best country in the global education system, with a literacy rate of 78.7%. The Kenyan education system is characterised by its compulsory nature, applicable to citizens between the ages of 6 and 17 [45].

**B. Emerging Adopters**

**Rwanda:** Rwanda's Education Sector Strategic Plan (ESSP) recognises the significance of pre-primary education and school readiness programs as a fundamental foundation for future learning. This acknowledgement is articulated within the broader context of the ESSP, spanning the years 2018/2019 to 2023/2024. The country has also introduced a mandatory coding curriculum from primary school, fostering digital skills and innovation among students. These efforts reflect Rwanda's commitment to becoming a knowledge-based economy and a regional leader in ICT integration, and the number of primary schools increased from 2,752 in 2015 to 2,909 in 2018. Concurrently, the gross enrollment rate increased from 135.3% to 137.5%, and the net enrollment rate increased from 96.9% to 98.3% in these years. Concurrently, the repetition rate exhibited a decline from 18.4% in 2015 to 13.4% in 2018 [48].

**Ghana:** Ghana's ICT for Accelerated Development Policy prioritises teacher training and the integration of digital tools into the classroom. As a result, 60% of educators now use digital tools in their teaching. However, device shortages and limited internet access in rural areas remain significant barriers to student access. Addressing these challenges requires increased investment in ICT infrastructure and targeted initiatives to bridge the digital divide [49].

**C. Lagging Countries:** Most African countries face significant Challenges in ICT in their Education Systems. For example, there was a lack of computer access in households and low internet access. Let's see some Lagging Countries below

**Burkina Faso:** Burkina Faso faces significant challenges in ICT integration, including unreliability of data and lack of human capacity [50]. Three ministries are involved in implementing the education system: the Ministry of Education, the Ministry of Social Affairs in charge of pre-primary Education, the Ministry of Basic Education and Literacy, and the third is the Ministry of Secondary Education.

**Chad and Niger:** In countries like Chad and Niger, conflict, poverty, and energy deficits severely hinder ICT adoption in education. Less than 1% of schools are equipped for digital learning, and limited access to electricity and internet connectivity further exacerbates the challenges. These countries require targeted interventions, including infrastructure development, donor support, and policy reforms, to overcome barriers to ICT integration [52].

### 2.5.3 Digital Skills Development

The integration of ICT into education in Africa has been driven by a combination of factors, including infrastructure investment, policy frameworks, public-private partnerships, and crisis-driven innovation [16]. These drivers have played a critical role in advancing ICT adoption, improving access to quality education, and enhancing learning outcomes across the region. This section examines the key drivers of ICT utilisation in education, highlighting successful initiatives, lessons learned, and the implications for scaling ICT integration in Africa [53].

#### A. Infrastructure Investment

Infrastructure development is a foundational driver of ICT utilisation in education. Reliable broadband networks, affordable internet access, and sustainable energy solutions are essential for enabling digital learning environments. Countries that have invested in robust ICT infrastructure have reported higher levels of ICT adoption and integration in their education systems [31].

#### B. Policy Frameworks

Effective policy frameworks are essential for driving ICT integration into education. National ICT strategies and teacher training programs provide the necessary guidance, resources, and capacity-building support to ensure the successful implementation of ICT initiatives [54].

**National ICT Strategies**

Countries with comprehensive national ICT strategies have achieved significant progress in integrating technology into their education systems. For instance, Mauritius' Digital Education Strategic Plan [55] Rwanda's Smart Education Masterplan provides clear roadmaps for aligning the efforts of ministries, donors, and private sector actors. These strategies prioritise investments in ICT infrastructure, digital content development, and teacher training, ensuring a holistic approach to ICT integration [56]. By developing collaboration and coordination among stakeholders, national ICT strategies can create an enabling environment for increasing digital learning initiatives.

**Teacher Training and Capacity Building**

Teacher training is a critical component of successful ICT integration, as educators play a central role in implementing digital learning tools and methodologies. South Africa's ICT

Professional Development Framework is a notable example of a policy initiative aimed at upskilling educators in digital pedagogy. The framework provides teachers with the knowledge and skills needed to effectively use ICT tools in the classroom, enhancing their ability to deliver engaging and interactive lessons. Similarly, Ghana's ICT for Accelerated Development Policy emphasises teacher training, with 60% of educators now using digital tools in their teaching. These initiatives highlight to ensure the effective utilisation of ICT in education [57].

### C. Public-Private Partnerships (PPPs)

PPPs have emerged as a key driver of ICT utilisation in education. They leverage the expertise, resources, and innovation of private sector actors to scale digital learning initiatives [25].

**Collaborative Models for ICT Integration**

Kenya's collaboration with Google for Education and Ghana's partnership with MTN for school connectivity exemplify the potential of PPPs to drive ICT adoption in education. In Kenya, Google for Education has provided schools with access to cloud-based learning platforms, digital content, and teacher training programs, enabling students and educators to harness the benefits of technology [58]. Similarly, MTN's partnership with the Ghanaian government has expanded internet connectivity to underserved schools, bridging the digital divide and promoting inclusive education. These collaborative models demonstrate the scalability and sustainability of PPPs in advancing ICT integration [25].

**E-Learning Adoption**

Most of Africa's countries have faced the adoption of e-learning, especially in response to the challenges of the COVID-19 pandemic. For Example, let's see Some Countries

**Kenya:** To address the challenges posed by the ongoing pandemic, the government of Kenya has adopted a variety of distance learning solutions. These include radio, television, and internet-enabled platforms such as smart TVs, tablets, computers, laptops, and smartphones. The government has also utilised video-sharing platforms such as YouTube and Facebook to disseminate recorded and live-streamed lessons [59].

The Kenyan educational platform Eneza Education offers mobile-based tutoring services for primary and secondary students, thereby expanding access to remote areas with limited internet connectivity. Concurrently, higher education is undergoing a digital transformation. The Université Numérique Cheikh Hamidou Kane, with a student body of over 60,000, has become Senegal's second-largest university[49].

**Zimbabwe:** The other country of interest is Zimbabwe, where the adoption and utilisation of e-learning platforms have been implemented in policy formulation and implementation in the higher education sector. Universities in Zimbabwe have adopted e-learning platforms to enhance educational delivery [60].

**Cote d'Ivoire:** During the pandemic, the government expeditiously developed a digital database of teaching programs, filming hundreds of hours of lessons for all school levels. These were initially broadcast on national television and subsequently made available online through a learning platform hosted by the Ministry of Education [61].

## 2.6 ICT and Telecommunication in Africa

Telecommunications are essential for enabling Internet of Things (IoT) connectivity and applications [62]. This section presents a comparative analysis of telecommunication infrastructure development across Africa. The analysis examines the role of the infrastructure in advancing ICT utilisation, the key drivers of progress, and persistent barriers [63]. The discussion encompasses mobile networks, fibre-optic expansion, Submarine Cables, and Satellite technologies. It also includes case studies from high-performing, emerging, and lagging countries.

### 2.6.1 The Role of Telecommunication in ICT Utilisation

1. **Job Creation & Innovation:** The generation of employment opportunities and the promotion of innovation are two significant factors in infrastructure development. The creation of employment opportunities, in particular, is a direct result of infrastructure development. Furthermore, infrastructure development has been shown to support the growth of digital economies [63]**.**
2. **Infrastructure Development:** Mobile Coverage, Telecommunication infrastructure, particularly mobile networks, has expanded rapidly in Africa. By 2021, mobile cellular coverage reached 88.4% of the population, with 77% having access to 3G signals and 44.3%to LTE mobile broadband, and also by broadband expansion, both fixed and mobile broadband markets have shown growth, enabling more people to access the internet and digital services [64].
3. **Economic Growth and Development:** Telecommunication is crucial for economic growth by facilitating business operations, enhancing supply chain management, and increasing employment opportunities in the ICT sector [65].

## 2.7 The Key Indicators of ICT Utilisation in Africa

The assessment of ICT development frequently utilises key indicators, including mobile and fixed broadband subscriptions, along with the development and utilisation of ICT in Africa [37].

While significant progress has been made in expanding ICT infrastructure and services, structural barriers to equitable access persist, particularly in rural and underserved areas [26].

### 2.7.1 Subscriptions for Mobile Broadband

Mobile broadband subscriptions, which indicate access to high-speed internet via mobile devices, serve as a pivotal metric for evaluating the utilisation of information and

communication technology (ICT) in Africa. In regions where fixed-line infrastructure is unavailable, mobile broadband is of particular significance. It provides a cost-effective and scalable solution that is especially well-suited to addressing the digital divide [43].

### Growth and Trends in Mobile Broadband Penetration

Exponential growth in mobile broadband subscriptions has been witnessed on the African continent over the past decade. This growth can be attributed to several factors, including improvements in network coverage, the increasing affordability of smartphones, and the emergence of competitive telecommunications markets [66].

A 10% increase in mobile broadband penetration has been shown to have a positive effect on GDP, with an estimated increase ranging from 1.0% to 2.5%. This phenomenon occurs through enhanced productivity, reduced search costs, and increased trade and competition. Network Expansion and 4G/5G Adoption: A significant portion of the observed expansion in mobile broadband coverage on the African continent is attributable to the upgrade of existing 2G sites to 3G/4G standards. However, approximately 190 million individuals still reside in areas without mobile infrastructure, rendering expansion costly. 5G penetration and the digital divide: While 5G is expanding globally, many Low- and Middle-Income Countries (LMICs) in Africa are unlikely to see widespread adoption by 2030. The emphasis, therefore, remains on the expansion of 4G coverage to address the persistent connectivity gap [67].

### The Key Factors Influencing Mobile Broadband Adoption

A multitude of factors have contributed to the mobile broadband adoption on the African continent**.** For example, let's see two of them.

### Affordability

A substantial impediment to the proliferation of mobile internet in Africa is its cost-related accessibility. Despite the existence of mobile broadband coverage, a considerable segment of the African population remains unconnected. For a considerable segment of the population, the expense of internet-capable devices and data remains prohibitive. Making device ownership a challenging prospect without subsidies or financing options. While there have been improvements in data affordability in some regions, costs remain high. For instance, the cost of 1GB of data can consume up to 15% of monthly income for underserved populations [67]**.**

### Access and Infrastructure

Reliable infrastructure is essential for mobile broadband adoption, especially in areas that don't have good internet access. Urban areas often have good internet coverage, but rural and remote areas often don't because it costs a lot to install internet there. Mobile networks can help people get internet access more quickly and cheaply than traditional internet connections. However, many people cannot access mobile broadband even when coverage exists because it is too expensive for them. Government policies, public-private partnerships,

and incentives for expanding infrastructure are important to closing this gap and making sure everyone has access to the internet [43].

### 2.7.2 Fixed Broadband Subscriptions

Fixed broadband provides reliable, high-speed internet, which helps businesses, schools, and people communicate better. While the cost of setting up the infrastructure can be a challenge, investing in fibre and satellite technology can help close the gap in access to these services. Having more access to the Internet leads to economic growth, better connections between people, and better public services. This makes it a key part of development [68].

Fixed broadband subscriptions to services that provide a reliable, high-speed connection to the public Internet, with download speeds of at least 256kbit/s. This includes technologies like cable modems, DSL, fibre-to-the-home/building, satellite broadband, and terrestrial fixed wireless connections. The count includes both home and business subscriptions, regardless of how they are paid. However, it excludes subscriptions that rely on mobile networks for internet access [69].

**The Role of Fixed Broadband in ICT Utilisation**

Fixed broadband is important because it allows for high-speed internet access. This makes online activities possible. Some common activities include teleconferencing, data transmission, accessing information, and Telecommunication and education. It is also useful for technological development [69]**.**

The implementation of fixed broadband has been demonstrated to have several notable benefits in developing regions. Chief among these is the reduction of information barriers. Furthermore, the introduction of fixed broadband has been found to support global integration. The efficacy of broadband in enhancing productivity is attributable to its capacity to streamline operations and foster knowledge sharing. The correlation between increased broadband penetration and economic growth is well-documented; furthermore, enhanced digital literacy and connectivity between local industries and global markets are key benefits of broadband infrastructure. Consequently, investing in broadband infrastructure is imperative for achieving digital transformation, facilitating ICT adoption, and ensuring sustainable growth [70].

**Barriers to Fixed Broadband Adoption and Growth**

Fixed broadband has the potential to drive digital transformation in Africa, but there are several barriers that are making it difficult for it to be adopted and grow. One big problem is that many rural and remote areas don't have reliable internet connections. Expanding this infrastructure is expensive and often not a priority because there are not many people living in these areas, and the cost of installing new networks is high**.**

**Digital literacy and awareness**

Digital literacy and awareness have been demonstrated to play a role. Many individuals lack the skills necessary to utilise digital tools effectively or are not fully informed about the advantages of fixed broadband, which can diminish the motivation to subscribe. Furthermore, regulatory and policy discrepancies have the potential to impede progress. Inconsistent regulations, limited competition, and delays in spectrum allocation can hinder the growth of a thriving broadband market. Addressing these challenges necessitates concerted efforts from governments, private enterprises, and international organisations to invest in infrastructure, reduce broadband costs, promote digital education, and establish conducive policy frameworks. Addressing these issues is imperative to unlocking the full potential of ICT across the continent [67].

### 2.7.3 Individuals Using the Internet

The third key indicator is individuals using the Internet in African countries. The proportion of the population that utilises the Internet serves as a foundational metric for assessing the degree of ICT adoption and utilisation across African nations. This metric shows how well infrastructure investments are working and how well digital inclusion policies are working. It does this by showing how many people are using online services and content [37].

**Measurement and significance**

When we say measurement and significance in internet users, we are individuals who have used the internet from a location and through many devices within a period [71]. In contrast to infrastructure metrics, which indicate the potential for access, this indicator discloses actual usage, thereby conferring significant value for the evaluation of digital divide dynamics and the tangible impact of ICT investments in the real world [10].

The following factors have been identified as highly influential regarding Internet utilisation.

- **Affordability:** The High cost of data and devices, which are a major continues to represent a substantial obstacle, with internet access accounting for more than 5% of average monthly income in numerous African countries. This figure exceeds the 2% target established by the UN Broadband Commission for affordability [72].
- **Significance:** The availability of content and services that are relevant to the local population and are expressed in local languages has been shown to have a significant impact on adoption rates [9] .
- **Network Availability:** The speed and reliability of internet connections have been shown to influence user decisions regarding the consumption of text-based and multimedia content. Regions with robust network availability tend to attract digital businesses and remote workers, thereby creating economic advantages [14].

# 3 RESEARCH METHODOLOGY

This thesis aims to compare countries in Africa from the point of view of ICT utilisation development across the continent. The research plan is designed to achieve the study's goals. It will assess key indicators, compare how well different regions use ICT, identify barriers using a theoretical framework, and create policy recommendations based on evidence. It will use a combination of quantitative (numerical) and qualitative (non-numerical) methods to measure ICT indicators and understand the contextual factors that influence ICT development across the continent.

The other chapters outline the objectives of the research and analysis of the results, which are covered by chapter 4. Chapter 5 focuses on discussing the results and providing police recommendations, and the last chapter presents the conclusions of the thesis.

## 3.1 Research Objectives

The objectives of this study are:

1. To assess the indicators of ICT utilisation: across African nations, identify and evaluate key metrics for measuring ICT diffusion and impact, such as broadband access, mobile Internet adoption, and digital literacy.
2. To compare the level of ICT adoption in regional analysis: compare ICT usage levels and outcomes across African sub-regions, such as North Africa, Sub-Saharan Africa, and other countries.
3. To evaluate the contribution of ICT to socio-economic progress, organisational effectiveness, and infrastructure improvement.
4. To recommend a policy based on the findings of this study. It is essential to propose actionable strategies that address systemic barriers, such as affordability.

## 3.2 Research Questions

1. What are the current levels of ICT development and digital adoption across African countries, based on standardised, internationally recognised indicators?
2. How do national ICT policies and implementation strategies differ between high-performing and low-performing African countries, and what patterns of effectiveness can be identified?
3. Do clusters of countries with similar levels of digital readiness emerge, and what structural, economic, or policy characteristics define these clusters?
4. What key factors enable or inhibit Africa's inclusive and sustainable ICT development?

## 3.3 Research Design

This study uses an explanatory sequential mixed-methods research design, integrating quantitative and qualitative approaches, to thoroughly analyse ICT utilisation in African countries. Methodological triangulation enhances the validity and reliability of the findings by examining the research problem from multiple perspectives [73]. The rationale for selecting a mixed-methods approach is ICT utilization's complex and multifaceted nature. This concept encompasses measurable indicators, policy frameworks, socioeconomic contexts, and cultural factors that influence technology adoption and impact.

The research design incorporates the following:

1. A quantitative analysis of ICT indicators to measure and compare levels of ICT infrastructure, access, usage, and skills across countries and regions.
2. A qualitative analysis of policy documents, national digital strategies, barriers, and enablers of ICT development.
3. A comparative analysis will be conducted to identify patterns, disparities, and best practices in ICT utilisation across different African countries and regions.

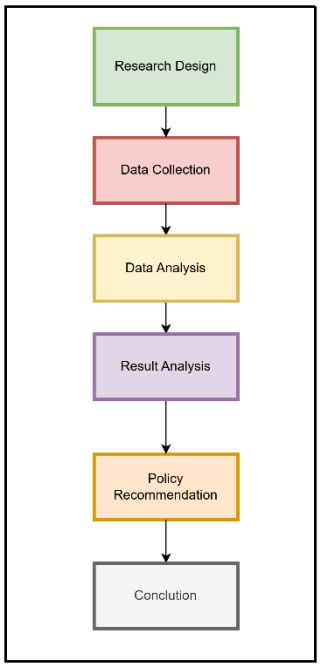



*Figure 1. Methodology of the study*

*Source: Author's creation*

## 3.4 Data Collection Methods

The study mostly uses secondary data from international and regional organisations that are known for their accuracy. This makes sure that the data can be compared from one country to another. Key data sources include [74], [75], and [76].

### 3.4.1 Quantitative Data Sources

The quantitative steps collect secondary data from the UN ITU, emphasising the following indicators: These indicators offer a quantitative assessment of ICT penetration and usage across African nations. Data was retrieved from the ITU's publicly accessible datasets for the most recent year available. Countries with complete data for all three indicators were included in the analysis.

ITU databases: The ITU provides consistent measurements of telecommunications infrastructure, internet access, and digital skills in African countries. This includes the following information:

- The number of mobile broadband subscriptions per 100 people
- The number of fixed broadband subscriptions per 100 people
- Percentage of individuals using the internet

### 3.4.2 Qualitative Data Sources

The qualitative step entails the analysis of policy documents and relevant literature to elucidate the patterns identified in the quantitative phase. The following sources were consulted:

- National ICT policy documents from selected African countries.
- World Bank data repositories: We provide economic indicators and digital adoption metrics through resources like the World Development Indicators (WDI).
- Reports and publications from the African Union and other regional organisations.

Where available, data will be collected from 2014 to 2023 to conduct a trend analysis in conjunction with a status assessment. When data gaps exist, particularly for countries with limited statistical capacity, the most recent available data will be utilised, accompanied by appropriate notation of limitations.

## 3.4 Data Analysis Methods

### 3.4.1 Quantitative Analysis

A range of statistical techniques and tools were used to conduct a quantitative analysis of ICT utilisation across African countries. We calculated descriptive statistics, including means, standard deviations, ranges, and medians, to summarise the distribution and

variability of key indicators such as mobile broadband, fixed broadband, electricity access, and literacy. Microsoft Excel (2023) was used in the analysis ToolPak to implement these calculations.

1. **Descriptive Statistics:** The objective of this analysis is to ascertain the distribution of Internet usage and other variables across the dataset. The visualisations employed included histograms and scatterplots, which were instrumental in conducting preliminary assessments of relationships and identifying outliers. These tools also provided an intuitive sense of how countries varied in their digital trajectories and helped guide the selection of variables for more advanced analysis. Computing means medians, ranges, and standard deviations for key ICT indicators were used to characterise the current state of digital development across countries. The statistics will offer a comprehensive overview of African countries' infrastructure, access, usage, and skills.

2. **Cluster analysis:** The technique is a statistical methodology working to classify nations into distinct groups based on the presence of commonalities in their respective ICT indicators. This approach facilitates the discernment of distinct patterns in the development and utilisation of ICT across nations. In order to further investigate the presence of patterns in the data, the second phase of analysis employed unsupervised machine learning in the form of K-means clustering. This technique enabled the researcher to categorise countries into discrete clusters based on their common characteristics, thereby providing a comparative perspective on the digital development profiles across the continent.

   The clustering process was executed using the Python programming language, with the pandas, scikit-learn, and matplotlib libraries playing a pivotal role in data management and visualisation. Prior to the implementation of the clustering process, a standardisation of all variables was conducted using z-scores. This procedure was undertaken to avert the potential for scale-related biases to influence the outcomes of the study. The variables employed for the clustering analysis encompassed Internet usage, mobile subscriptions, fixed broadband subscriptions, log-transformed GDP, GDP growth rate, and literacy rate. The selection of these six indicators was made with two criteria in mind: their relevance to both infrastructure and human development and their ability to provide a well-rounded basis for grouping countries.

   The elbow method was applied to determine the optimum number of clusters through the implementation of K-means clustering with multiple k values. algorithm for a range of cluster values and subsequently plotting the resulting inertia values (within-cluster sum of squares). The inflexion point, at which the curve flattened, was identified as the optimal value of k, as it indicated diminishing returns from adding more clusters. The elbow method indicated that three clusters provided the most interpretable and efficient grouping.

3. **Correlation Analysis:** To look at how the three indicators are related to each other, and, depending on whether the data is normally distributed, to look at how they are related to each other.

    - Different ICT indicators (e.g., mobile penetration and internet usage)
    - ICT indicators and socioeconomic factors (e.g., GDP per capita, education levels)
    - ICT indicators and development outcomes (e.g., economic growth, human development indices)

4. **Regression Analysis:** to evaluate the predictive capability of mobile and fixed broadband subscriptions on internet usage rates. To this end, a multiple linear regression analysis was conducted using Microsoft Excel. The dependent variable, Internet usage, was modelled against six independent variables: mobile cellular subscriptions, fixed broadband subscriptions, log-transformed GDP, GDP growth rate, literacy rate, and access to electricity. The objective of this regression was to ascertain whether infrastructure and economic indicators that are frequently cited in the literature were significantly associated with the level of Internet use within a country.

   The regression outputs, including coefficients, standard errors, t-statistics, and p-values, were generated using Excel's analysis Tool Pak. The regression results were evaluated for both statistical significance and explanatory power, with particular attention paid to the model's R-squared value and the interpretation of individual predictors. The findings indicated that none of the independent variables, despite their intuitive significance, attained statistical significance at conventional levels. Furthermore, the model as a whole accounted for a negligible portion of the variation in Internet usage. These findings underscored the necessity for a more nuanced analytical approach, one that extends beyond the limitations of simple linear modelling.

### 3.4.2 Qualitative Analysis

Qualitative data analysis will focus on understanding the contextual factors, barriers, and enablers of ICT development through systematic examination of policy documents using document analysis, comparative policy analysis and gap analysis.

1. **Document Analysis**: Document analysis was conducted to systematically review national ICT policy documents, regional strategies, and international reports relevant to ICT utilisation in Africa. This method allowed for the extraction of key policy objectives, strategic initiatives, and implementation outcomes across different countries and regions.

A structured coding framework was developed based on themes identified in the literature review, including ICT infrastructure investment, digital education policies, and telecommunication expansion initiatives. By analysing official documents and secondary

literature, the study gained insight into how government strategies align with broader development goals, such as those outlined by the African Union's Agenda 2063 and the World Bank initiative. This analysis will identify:

- Policy priorities and objectives related to ICT development
- Implementation of mechanisms and governance structures
- Monitoring and evaluation frameworks
- Alignment with international best practices

2. **Comparative Policy Analysis:** In addition to a thorough document analysis, a comparative policy analysis was conducted to evaluate the similarities and differences in ICT development approaches across African countries. The present analysis focused on policy comprehensiveness, effectiveness, adaptability, and alignment with international best practices. The proposed framework is supported by examples identified in the extant literature, including Kenya's national ICT master plans, Rwanda's Smart Education strategies, and the ECOWAS regional digital policies.

   The comparative policy analysis assessed the following:

   - Policy objectives have been identified: The degree of emphasis on digital infrastructure, education, financial inclusion, and innovation ecosystems is a critical consideration.
   - Implementation Mechanisms: The following elements comprise the institutional structures, funding models, and public-private partnerships that support the development of ICT.
   - Monitoring and Evaluation Systems: This paper will propose strategies for assessing progress, as well as accountability measures and adaptive learning in policy execution.
   - The challenges and gaps that have been identified. The identification of persistent barriers, including rural-urban divides, affordability constraints, and regulatory inefficiencies, is essential for effective policy development.

   The analysis provides a nuanced understanding of why certain countries have advanced more rapidly in ICT utilisation compared to others, despite facing similar macroeconomic conditions.

3. **Gap Analysis**: A gap analysis was conducted to identify discrepancies between policy intentions and actual outcomes. This involved a comparison of planned initiatives (e.g., rural broadband rollouts, digital literacy programs, and e-government services) against real-world ICT adoption and utilisation metrics sourced from ITU, World Bank, and AU reports. The subsequent gap analysis revealed critical success factors and persistent challenges, which informed the policy recommendations proposed later in the study. The qualitative analysis findings will contextual quantitative patterns and disparities in ICT development across countries [64].

## 3.5 Analytical Framework

To structure the analysis and ensure comprehensive coverage of ICT utilisation dimensions, the study employs a multidimensional analytical framework encompassing five key dimensions. Those dimensions are selected based on insights from the literature review and aligned with the global ICT measurement standards.

1. **ICT Infrastructure Dimension**: Infrastructure is the backbone of economic development and digital development, as emphasised by studies such as [4] and [16]. Assessing the foundational physical and technical systems that enable digital connectivity:

    - Mobile network coverage (2G, 3G, 4G, 5G)
    - Fixed broadband infrastructure (fibre optic networks, last-mile connectivity)
    - Energy infrastructure supporting ICT
    - Computing infrastructure

2. **Adoption and Usage of ICT**: Effective infrastructure must translate into widespread use to yield socio-economic benefits [10] and [17] Measuring actual utilisation of available technologies across different sectors.

    - Mobile broadband subscriptions and active usage
    - Internet penetration and usage patterns
    - Digital service adoption (e-government, e-commerce, digital financial services)
    - Business ICT adoption (by size and sector)
    - Sectoral ICT utilisation (education, internet, agriculture, etc.)

3. **Digital Skills**: The literature review highlights digital skills as crucial for leveraging ICT investment, with examples from Kenya, Rwanda, and Ghana [45] ,[77] and [78] In evaluating human capacity for effective ICT utilisation, some of the indicators are:

    - Basic digital literacy levels
    - ICT education and training (formal and informal)
    - ICT workforce development
    - Research and innovation capacity

4. **Policy and Regulatory Dimension**: Analysing enabling environments for ICT development, as we discussed in section 2.2, the government plays a pivotal role in the development of every country, and it addresses the gaps and the regulatory reforms [14] and [19] . Additionally mentioned below

    - National ICT policies and digital transformation strategies
    - Regulatory frameworks for telecommunications and digital services
    - Universal access and service policies
    - Public investment in digital development
    - Competition policy in ICT markets

5. **Socioeconomic Impact**: It is imperative to measure the impact of ICT on broader development goals to comprehend its transformative capacity. Assessing outcomes and benefits of ICT utilisation [37] , [6] and [9]:
    - Economic growth and productivity effects
    - Job creation and labour market impacts
    - Financial inclusion outcomes

This framework enables systematic comparison across countries and identification of strengths, weaknesses, and gaps in ICT utilisation. It also facilitates analysis of how different dimensions interact to enable or constrain digital development.

## 3.5 Ethical Considerations

Although the study relies exclusively on publicly available secondary data and policy documents, ethical considerations remain an important aspect of research design. Care is taken to accurately represent and cite all sources of information. Additionally, when comparing national performances, the study avoids judgmental language and instead adopts a developmental lens that focuses on learning and capacity-building rather than labelling countries as failures or successes. The research is conducted with a commitment to fairness, transparency, and respect for the diverse contexts in which digital development occurs.

## 3.6 Limitations

Several limitations of the study are acknowledged. First, the availability and completeness of ICT data vary across countries and years, which may affect the robustness of some statistical comparisons. Second, national-level data may obscure significant subnational disparities, such as urban-rural divides or gender-based inequalities in ICT access [79]. Third, policy documents differ in scope, structure, and recency, making direct comparison challenging in some cases. Fourth, the temporal alignment between the most recent data and the current status of policy implementation may not always be perfect, leading to potential mismatches between statistical and narrative findings. These limitations are mitigated through cautious interpretation, emphasis on triangulation, and clear communication of the study's scope and boundaries.

# 4 DATA ANALYSIS RESULTS

## 4.1 Introduction to Data Analysis

This chapter presents an analysis of data collected from secondary sources, primarily the World Bank's WDI [75]. The objective of this analysis is to examine, assess, and compare patterns of ICT-related development across African countries. The indicators examined encompass fixed and mobile broadband subscriptions, internet usage, electricity access, literacy rates, human capital, GDP, and ICT-related trade (import and export) activities.

The data analysis is structured to address the core objectives of the study, which are to assess the state of ICT development across Africa, to explore how ICT indicators relate to broader socioeconomic factors, and to provide evidence-based insights for policy formulation and strategic development. A comprehensive array of statistical methodologies has been utilised, encompassing both descriptive and inferential approaches. Descriptive statistics, including the mean, minimum, and maximum values, are employed to summarise the distribution of ICT indicators. Visual tools, such as line graphs and bar charts, facilitate trend analysis across countries.

Furthermore, correlation analysis is employed to assess the strength and direction of relationships between key indicators. Additionally, statistical techniques such as regression and clustering are implemented to elucidate predictive and group-level insights. These analytical techniques form the basis for interpreting how infrastructure, access, education, and economic conditions interact in shaping digital inclusion and ICT expansion in the region.

The findings from this chapter underscore both the disparities and commonalities observed among African countries, thereby establishing a foundation for targeted policy recommendations that will be elaborated upon in the final chapter.

## 4.2 Descriptive Statistics

This section presents a summary of key ICT and socio-economic indicators across African countries using descriptive statistics. The analysis incorporates metrics such as mean, median, range, and standard deviation to assess the distribution and variability of the data. The indicators that were analysed are as follows.

1. Mobile broadband subscriptions (per 100 people)
2. Fixed broadband subscriptions (per 100 people)
3. Individuals using the Internet (percentage of the population)
4. Access to electricity (percentage of the population)
5. GDP per capita (current US$)
6. Human Capital Index (HCI)

**Definitions of Indicators**

The development indicators of 44 African countries have been examined across the period from 2014 to 2023. The data was collated from international sources, including the ITU and the World Bank, and the data covers 44 African countries from 2014 to 2023. For indicators with missing values (marked as N/A), only the available data were used in the descriptive statistical analysis. This means that means and other summaries were calculated based solely on countries with reported values, without estimating or imputing missing data. The objective of this analysis is to furnish a foundational overview of the digital landscape of Africa by accentuating disparities.

1. **Access to electricity (percentage of population)**

It shows the percentage of the population that has access to electricity. This is a basic requirement for setting up digital infrastructure and using ICT.

The region exhibits significant disparities. It is evident that countries in the North African region, including Algeria, Egypt, and Tunisia, have attained a significant level of universal electricity access, with estimates indicating that 100% of the population in these countries has access to electricity (as projected by 2022). In contrast, Central and Eastern African countries such as South Sudan (4.3–8.4%), Burundi (7–11.6%), and Chad (8.4–12%) remain severely under-electrified. Significant progress has been observed in several African countries, including Ethiopia, which demonstrated an increase from 27.2% in 2014 to 55.4% in 2023, and Rwanda, which exhibited a notable surge from 19.8% to 63.9%. Libya experienced a slight decline from 75.5% to 73.2%, attributed to prolonged political instability.

2. **The number of fixed broadband subscriptions per 100 people**

This shows how high-speed internet is available through wired technologies like DSL, fiber, or cable. It is a direct measure of ICT infrastructure capacity. From 2014 to 2023, only a small number of countries demonstrated significant broadband penetration. Mauritius (14.1–26.9 per 100 people) and Seychelles (11.3–30.8) lead the region, reflecting their robust infrastructure. In contrast, countries such as Chad (0–0.002), Niger (0.015–0.155), and South Sudan (0.001–0.002) demonstrate virtually no broadband access. In the case of certain countries, such as Cape Verde (3.7–7.2) and Botswana (1.5–5.5), modest yet stable growth was observed. It is noteworthy that Nigeria's broadband access remained static (0.008–0.051), despite its status as the continent's largest economy.

3. **Mobile Cellular Subscriptions (per 100 people)**

It shows the number of active mobile phone connections compared to the number of people. It shows how well people in Africa can connect to the internet on their phones.

Mobile connectivity is widespread but uneven. South Africa (144–168 subscriptions per 100 people) and Tunisia (122–129) lead in mobile penetration, often exceeding one subscription

per person due to multiple SIM ownership. Eastern African countries are showing consistent growth: Kenya rose from 73 to 122 subscriptions, and Tanzania from 63 to 92, reflecting increasing mobile access.

4. **Gross Domestic Product (Currency in US Dollars)**

GDP in absolute terms in billion currency terms. This indicator aims to provide a quantitative measure of a country's economic size and its potential to fund investments in infrastructure and information and communication technology (ICT). GDP levels vary drastically. Nigeria (574B in 2014) and South Africa (381B) dominate economically, while smaller economies like Burundi (2.7B) and Gambia (1.2B) struggle with limited fiscal capacity.

5. **Human Capital Index (HCI)**

The composite metric under discussion is intended to reflect the expected productivity of future workers, with a view to accounting for health and education outcomes. The World Bank asserts that a higher HCI is associated with stronger ICT uptake.

The HCI clearly illustrates this disparity: Mauritius (0.63) and Seychelles (0.68) show high levels of human development compared to Chad (0.29) and South Sudan (0.30). Literacy rates are highest in Northern and Southern Africa (e.g., South Africa: 92.3%, Tunisia: 85.2%) and lowest in countries such as Burkina Faso (35–39%) and Mali (31–35%).

6. **Individuals Using the Internet (percentage of the population)**

This indicator is intended to represent the percentage of the population who have accessed the internet in the past three months, regardless of the device or connection method used. It is imperative to acknowledge that this is a pivotal metric of digital inclusion.

Internet usage among individuals remains highly uneven across the continent. The most recent data indicates that approximately 35% of the population had internet access, although this figure varies considerably. Countries such as Mauritius (81–85%), Seychelles (76–83%), and South Africa (65–70%) have attained relatively high levels of internet penetration. This is indicative of mature digital ecosystems and extensive service availability.

Conversely, several countries in Central and Eastern Africa demonstrate alarmingly low rates. The lowest rates of internet usage are observed in South Sudan (6–9%), Burundi (8–10%), and Chad (6–7%), suggesting a combination of infrastructure deficits, affordability barriers, and limited digital literacy. Certain nations have achieved considerable progress in this regard. For instance, Kenya experienced a notable increase from approximately 37% to over 57% between 2014 and 2023, driven by substantial mobile data expansion and public-private digital initiatives.

These disparities highlight not only infrastructural challenges but also socio-economic and policy-based factors influencing internet accessibility. Even though mobile broadband has facilitated an increase in reach, the cost of devices, low literacy levels, and digital skill gaps continue to act as limiting factors in many rural and underserved areas.

The descriptive statistics evidently demonstrate the fragmented state of ICT development in Africa. It is evident that while certain nations have achieved considerable progress in terms of infrastructure and human capital, others continue to face significant challenges due to limited electricity access, inadequate economic capacity, and ineffective policy implementation. These disparities underscore the necessity for bespoke digital strategies that address the specific developmental and infrastructural requirements of each nation. This preliminary statistical synopsis constitutes the foundation for the ensuing cluster and regression analyses, which are designed to discern patterns and causal relationships in the growth of ICT.

## 4.3 Intercorrelation Analysis

This study aimed to investigate the relationships among key ICT and socioeconomic indicators in African countries. To this end, a correlation matrix was constructed using data extracted from the World Bank WDI database. The matrix presents the Pearson correlation coefficients among a set of variables, including fixed and mobile broadband subscriptions, internet usage, access to electricity, literacy rates, human capital, GDP, and ICT-related trade.

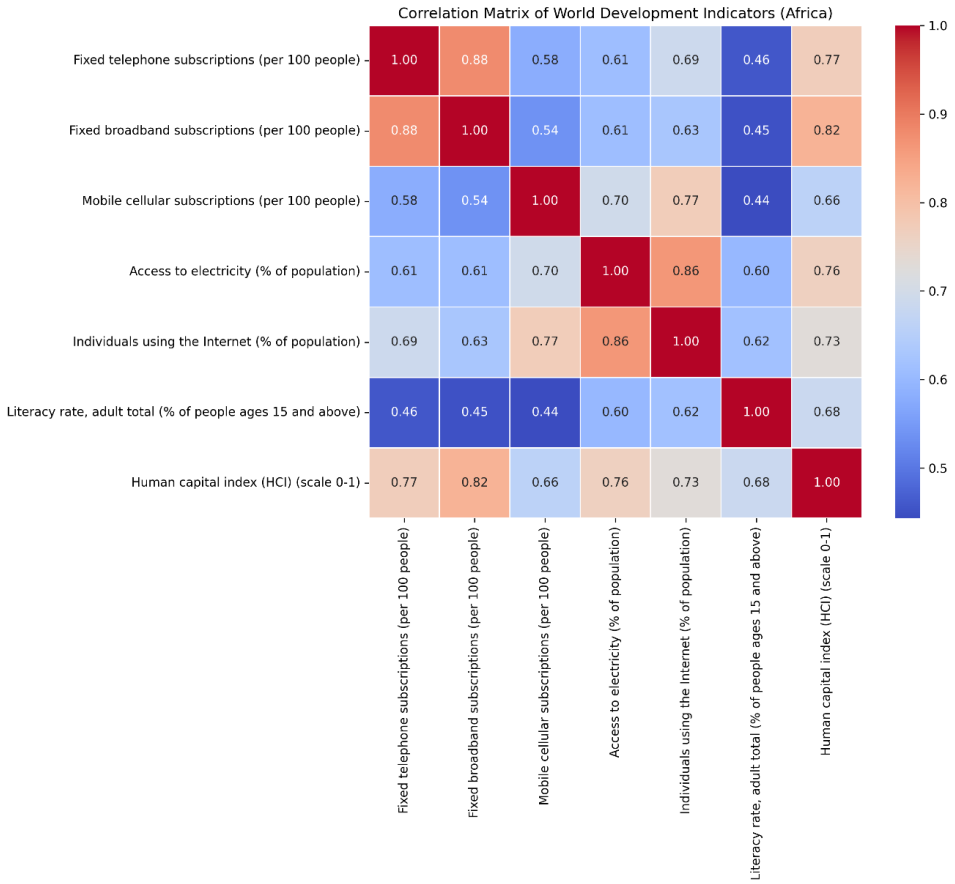



*Figure 2. Correlation Matrix of Development Indicators*

*Source: World Bank Development Indicators (2020)*

Figure 2 above shows the correlation heatmap, with values ranging from 0.44 to 1. The correlation matrix reveals that all indicator values are positively correlated, suggesting direct relationships among them. Stronger positive correlations are represented by darker red shades, while weaker associations are indicated by blue shades.

The following observations merit particular attention and require careful interpretation.

**Usage of the Internet and Mobile Subscriptions**

The correlation has been determined: Internet Usage and Mobile Subscriptions **r = 0.84.**

A robust positive correlation indicates that an increase in mobile cellular subscriptions is concomitant with an increase in internet usage. This phenomenon aligns with the prevailing trends in mobile-driven internet access across Africa, where mobile broadband frequently serves as the predominant mode of connectivity.

**Internet Usage and Access to Electricity**

The correlation between internet usage and access to electricity is significant, with a Pearson's r value of **r=0.87**.

This robust correlation suggests that infrastructure readiness, specifically the availability of electricity, continues to be a pivotal factor in facilitating digital access. The correlation between the extent of electricity coverage in a country and its propensity to encourage regular internet use is statistically significant.

**Fixed Broadband and Fixed Telephone Subscriptions**

The following regression model was employed to assess the relationship between Fixed Broadband and Fixed Telephone Subscriptions, with a determination of **r=0.88**.

A correlation has been demonstrated between the presence of established fixed-line telecommunication networks and a higher degree of fixed broadband penetration within countries. However, in many African nations, the development of fixed infrastructure is limited, which leads to a greater reliance on mobile networks.

**Fixed Broadband and Literacy Rate**

The correlation coefficient between the literacy rate (adult total, expressed as a percentage of the population aged 15 and above) and fixed broadband subscriptions (per 100 people) in the given correlation matrix is **r=0.45**. A correlation coefficient of **0.45** indicates a moderate positive relationship between literacy rates and fixed broadband subscriptions.

**Human Capital Index and ICT Indicators**

The HCI demonstrates a robust correlation with fixed broadband **r=0.82** and internet usage **r= 0.73**. This finding underscores the potential of ICT access to enhance education, skills development, and workforce quality, central themes in the author's thesis.

**Literacy Rate and Internet Usage**

A correlation coefficient of **r=0.63** was identified between the literacy rate and internet usage.

A moderately strong correlation indicates that literacy remains an important factor for digital engagement, especially for online services and education.

## 4.4 Cluster Analysis

**Cluster Analysis of African Countries Based on Development Indicators (2014–2023)**

To complement the regression model and reveal comparative patterns, a K-means clustering analysis was conducted using six standardised variables: The following variables were considered: internet usage, mobile subscriptions, fixed broadband subscriptions, GDP Per Capita, GDP growth, and literacy rate. This study aimed to group African countries into clusters based on similarities in energy access, digital infrastructure, economic strength, and human capital. This approach is intended to identify patterns and prioritise interventions. The following variables were selected for analysis.

1. Access to Electricity (2023): The percentage of the population is indicated here.
2. Fixed Broadband Subscriptions (2023): The following calculation is based on a percentage metric. The numerator is the population size, and the denominator is the number of cases.
3. GDP: for the year 2023: The current US dollar (log-transformed for normalisation) is represented by the following equation:
4. HCI: The scale ranged from 0 to 1 (latest available).
5. Mobile Cellular Subscriptions (2023): The following calculation is based on a percentage metric, with the numerator representing the population size (in this case, 100 people) and the denominator representing the percentage of people who meet the criteria.

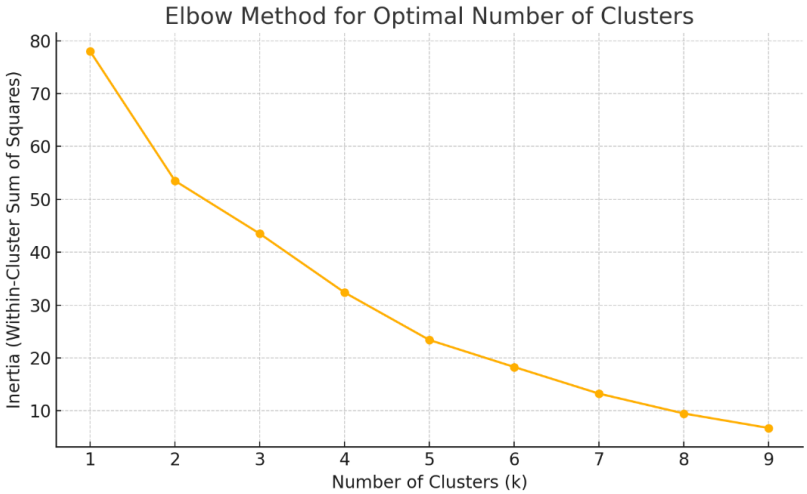



*Figure 3. Elbow Plot For K-Means Clustering*

*Source: Author Creation*

The elbow method, as illustrated in Figure 3, to ascertain the optimal number of clusters. The plot displays a discernible inflexion at k = 3, indicating that a three-cluster model effectively captures the data structure.

Following the implementation of the clustering methodology, the countries were grouped into three distinct profiles. Cluster 0 encompasses nations that exhibit moderate Internet usage and mobile access yet exhibit low levels of broadband connectivity and literacy. Cluster 1 comprises countries with elevated GDP and literacy levels yet underwhelming Internet usage patterns. It is evident that Cluster 2, which consists exclusively of Mauritius, is the digital frontrunner. The mean values of the key indicators for each cluster are summarised in the Table.

| Cluster 0 | Cluster 1 | Cluster 2 |
|---|---|---|
| Countries = 20 | Countries = 22 | Countries = 11 |
| Internet Usage = 46% | Internet Usage = 39% | Internet Usage = 72% |
| Mobile Subscription 113 per 100 | Mobile Subscription 118 per 100 | Mobile Subscription 152 per 100 |
| Broadband 0.6 per 100 | Broadband 1.56 per 100 | Broadband 25.7 per 100 |
| GDP Per Capital = 23.4% | GDP Per Capita = 25.1% | GDP Per Capital = 28% |
| Literacy = 57% | Literacy = 81.5% | Literacy = 92% |
| GDP Growth =2.87% | GDP Growth =2.12% | GDP Growth = 2.12% |
| Examples of Countries: Kenya, Ghana, Zambia, Ethiopia | Examples of Countries: South Africa, Namibia, Nigeria | Examples of Countries: Mauritius and Seychelles |

*Table 1.Cluster Summary Table*

*Source: Author Creation*

A comparative analysis of ICT development clusters reveals significant disparities in technological adoption and socio-economic infrastructure across African nations. As shown in Table 1, Cluster 0 represents countries with minimal ICT adoption. These countries are characterised by low internet usage (15.29%), limited mobile and fixed broadband subscriptions (55.66 and 0.22 per 100 people, respectively), and restricted electricity access (29.45%). It is clear that these nations also report modest literacy rates (46.30%) and GDP per capita levels. Cluster 1, made up of countries with medium ICT development, has shown clear improvements. Internet usage has risen to 29.31%, mobile subscriptions are at 93.01 per 100 people, and electricity access has expanded to 56.17%. Despite the ongoing challenge of fixed broadband access (0.75 per 100 individuals), significant progress is evident in literacy and economic indicators. Cluster 2, which is indicative of high ICT adoption, includes 11 countries distinguished by elevated internet usage (62.96%), robust broadband infrastructure (7.84 per 100), and comprehensive electricity access (91.44%). This cluster stands out with its consistently high literacy rates and the highest GDP per capita among the

groups. The data leaves no room for doubt: there is a strong positive correlation between ICT development and socio-economic advancement.

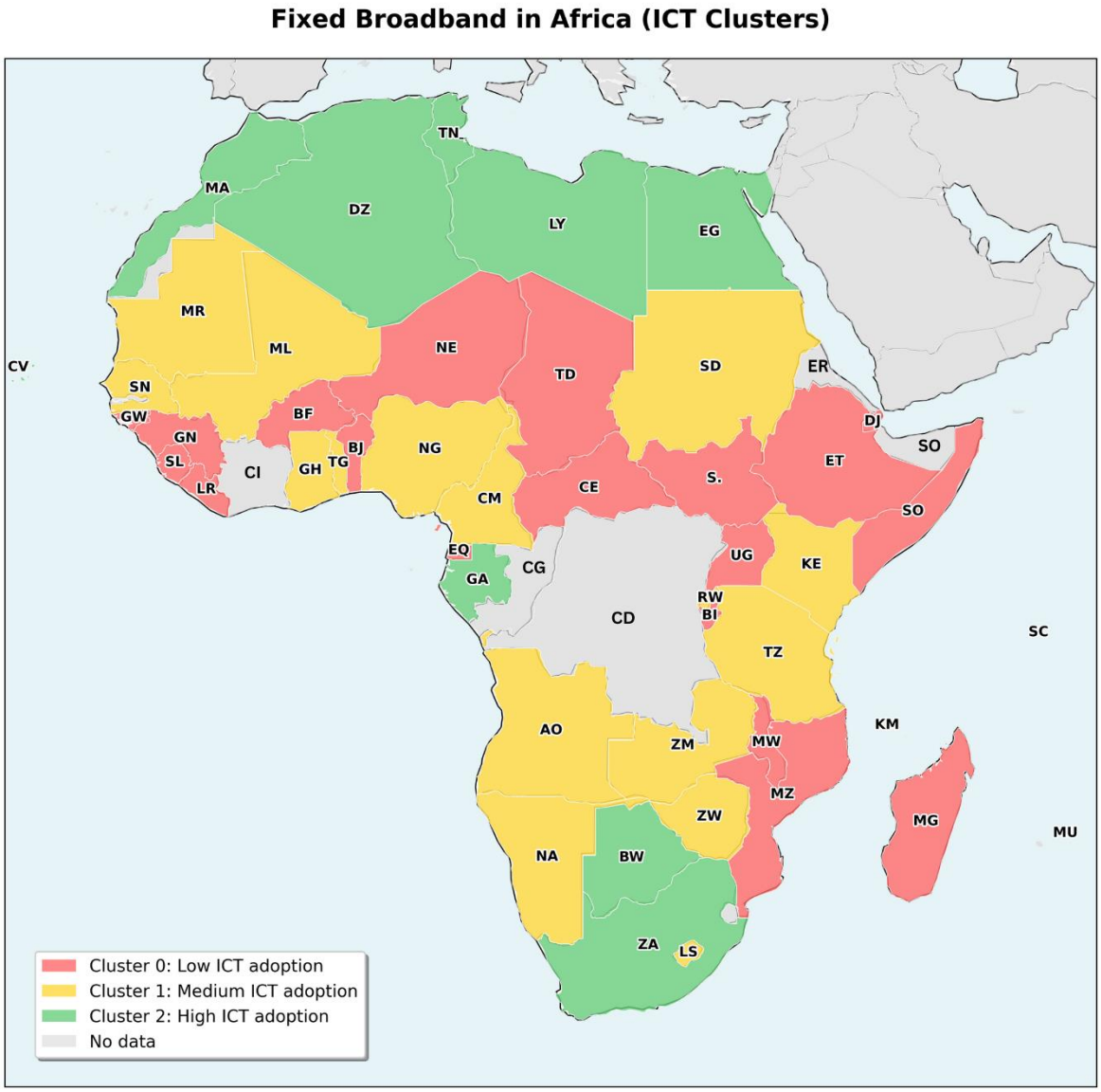



*Figure 4. Fixed Broadband Subscriptions*

*Source: Author Creation*

Figure 4 shows a map of the whole continent of Africa. It shows the number of fixed broadband subscriptions grouped by four clusters. This map uses the most recent data available to show differences in digital infrastructure. Fixed broadband, typically delivered via fibre-optic or DSL connections, is a crucial component of reliable, high-speed internet. It supports digital transformation in areas like education, business, and public administration.

A detailed look at the map shows that the adoption of fast internet is still very low in many parts of Africa. Most countries are in Group 0 (red). This means that not many people have computers or the Internet. This pattern is especially clear in landlocked and lower-income countries such as Chad, the Central African Republic, South Sudan, and Burundi, where the penetration rate is essentially zero. These findings suggest that there is either a complete lack of fixed broadband infrastructure or such minimal coverage that it is statistically negligible.

Even in countries with infrastructure that can be measured, the numbers are still small. Nigeria, the country with the most people in Africa, has only 0.2 subscriptions for every 100 people. Kenya and Uganda are also leaders in the ICT sector in their region. They have between 0.2 and 1.0 subscriptions for every 100 people. This shows that most people in Africa don't have access to fast internet at home. This is similar to what we've seen in other parts of the world.

On the other hand, a few countries stand out for their higher fixed broadband use, which puts them in Cluster 2 (green) for high ICT adoption. For example, Algeria and Egypt report averages of 8.0 and 7.1 subscriptions per 100 people, respectively. These numbers are much higher than the rest of the continent. These numbers show that we have been investing a lot in infrastructure, that more people are living in cities, and that we are updating old telecommunications systems. South Africa, Botswana, and Namibia also have above-average rates (2.5 to 2.8). This shows how improving the economy, specific policies, and city planning can lead to better internet connections.

The map's grey areas show countries where there is not enough data. This is a common problem in places like Somalia, Western Sahara, and some parts of the Sahel. These data gaps point to larger problems, such as digital exclusion and the challenges of setting up and collecting data in unstable or fragile states.

In short, the map shows that there is still a big difference in how many people in Africa have access to fast internet. Only a few countries have a lot of people with fast internet, while most countries are just starting to get fast internet. This landscape needs specific policy changes, more investment in infrastructure, and regional cooperation to close the digital gap and allow everyone to participate in digital transformation.

## 4.5 Regression Analysis

To see if important infrastructure and economic factors could explain Internet usage, a multiple linear regression was done. Internet usage was used as the dependent variable in this study. The independent variables included mobile cellular subscriptions, fixed broadband subscriptions, log-transformed GDP, GDP growth rate, literacy rate, and access to electricity. The regression model produced the results shown in Table 2.

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.296205668 |
| R Square | 0.087737798 |
| Adjusted R Square | -0.026294978 |
| Standard Error | 24.08429076 |
| Observations | 46 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 5 | 2231.489058 | 446.2978115 | 0.769408596 | 0.577397102 |
| Residual | 40 | 23202.12246 | 580.0530616 | | |
| Total | 45 | 25433.61152 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -29.7176324 | 59.38155281 | -0.500452262 | 0.619499166 | -149.7322274 | 90.29696262 | -149.732227 | 90.29696262 |
| Mobile_Subscriptions | 0.021425786 | 0.106675647 | 0.200849838 | 0.841833802 | -0.194173738 | 0.237025311 | -0.19417374 | 0.237025311 |
| Fixed_Broadband | 0.235230682 | 0.651650617 | 0.360976689 | 0.720016431 | -1.081804343 | 1.552265707 | -1.08180434 | 1.552265707 |
| GDP_Growth | -0.433824017 | 0.879829947 | -0.493077121 | 0.624654277 | -2.21202667 | 1.344378635 | -2.21202667 | 1.344378635 |
| Log_GDP | 2.56049402 | 2.56898552 | 0.99669461 | 0.32490425 | -2.631619392 | 7.752607432 | -2.63161939 | 7.752607432 |
| Access to electricity (% of population) | 0.158692403 | 0.136365238 | 1.163730625 | 0.251428022 | -0.116912023 | 0.434296829 | -0.11691202 | 0.434296829 |

*Table 2. Regression Output Summary*

*Source: Author Creation*

The regression coefficients showed that higher GDP and literacy were associated with more Internet usage. However, GDP growth had a slightly negative effect. However, none of the variables were statistically significant at the 0.05 level. The model's R-squared value was 0.0877, meaning that only 8.8% of the variation in Internet usage could be explained by the model. This suggests that infrastructure and economic factors are not the only reasons for differences in Internet usage.

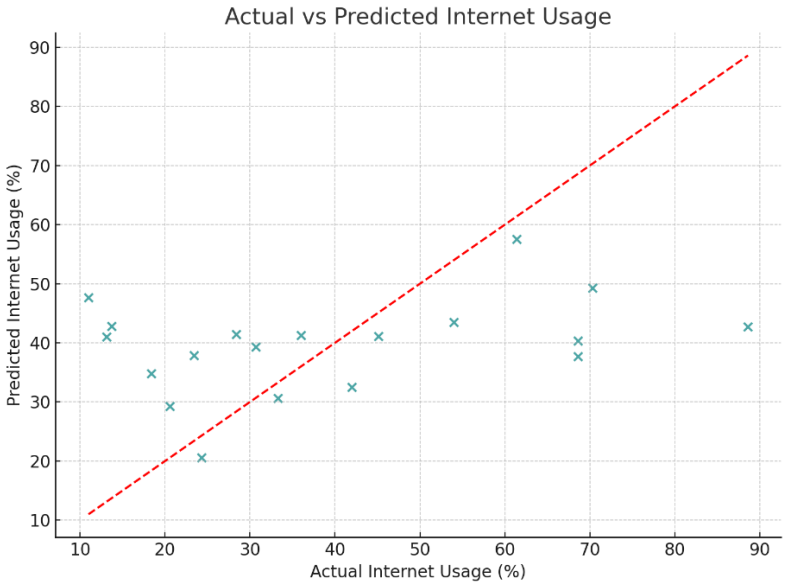



*Figure 5. Actual vs. Predicted Internet Usage*

*Source: Author Creation*

We checked the quality of the regression model using an actual vs. predicted plot. As shown in Figure 5, the scatterplot reveals that the predicted values do not closely match the actual Internet usage. The points are scattered widely away from the 45-degree line, which suggests that the model is not very good at predicting the outcome.

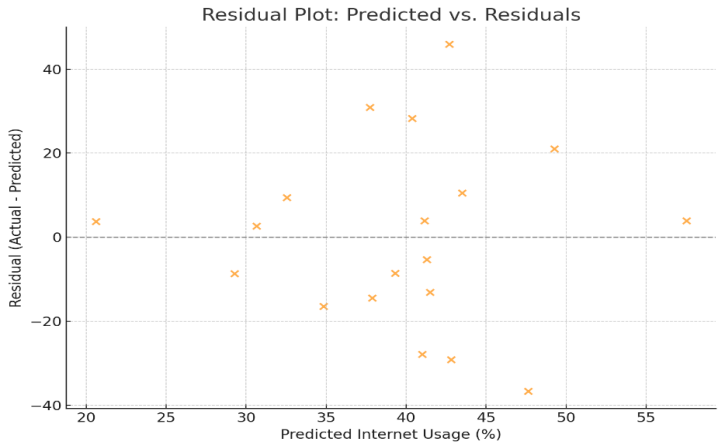



*Figure 6. Residual Plot: Predicted VS Residuals*

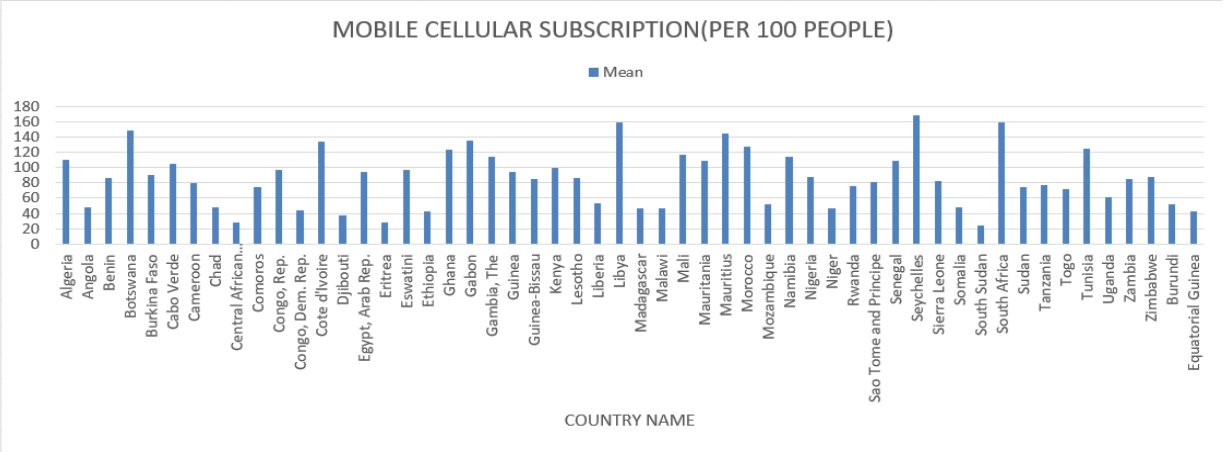
*Source: Author Creation*

The plot in Figure 6 shows that the model doesn't fit well. The residuals are scattered randomly around the horizontal axis, with no clear pattern. This indicates heteroscedasticity and confirms that key variables are missing from the model.

Together, these findings underscore the complexity of digital inclusion. Internet usage depends on variables beyond infrastructure and macroeconomic status, possibly involving qualitative factors such as affordability, awareness, policy quality, and social inclusion.

## 4.6 The Key Indicators

### 4.6.1 Mobile Cellular Subscriptions (per 100 people) in Africa Mean of (2014-2023)




*Graph 1. Mobile Cellular Subscription by Using Mean*

*Source: Author Creation*

Graph 1 presents a comparative analysis of mobile cellular subscriptions per 100 people across a wide range of African countries, based on the mean value for each country. This indicator is indicative of the level of mobile penetration in a given population; values above 100 indicate that, on average, individuals possess more than one mobile line. High mobile subscription rates are frequently interpreted as a sign of widespread access to basic communication services and are commonly associated with the early stages of digital connectivity.

The chart illustrates that there is considerable variation in mobile cellular subscription rates across countries. Several countries, including Gabon, Seychelles, Botswana, South Africa, and Libya, report values well above 150 subscriptions per 100 people. These figures suggest high levels of mobile connectivity, possibly due to widespread dual-SIM use, competitive telecom markets, and urban concentration of services. Such conditions frequently motivate individuals to subscribe to multiple mobile plans for reasons such as price optimisation, variations in network coverage, or the need for distinct usage for personal and professional purposes.

In contrast, countries such as Eritrea, Somalia, the Central African Republic, and Chad exhibit subscription rates that are consistently below 50 per 100 inhabitants, suggesting a marked deficit in mobile service accessibility. The observed decline in mobile phone ownership may be indicative of underlying infrastructural challenges, ongoing conflict or instability, inadequate regulatory frameworks, or economic hardship, which collectively impede both the supply and affordability of mobile devices and services.

The majority of countries exhibit a moderate range of mobile subscriptions, typically ranging from 80 to 120 subscriptions per 100 people, suggesting a fair but uneven level of mobile access. According to the most recent data, nations such as Kenya, Ghana, Namibia, and Morocco are classified as having a middle-range mobile penetration rate. This category indicates markets where mobile phone adoption has increased steadily but not excessively. These countries frequently possess an expanding mobile infrastructure, in conjunction with ongoing initiatives to address disparities in access and affordability.

The substantial discrepancy observed in the chart serves to reinforce a pivotal theme that has emerged from earlier findings in this chapter: while mobile access is pervasive in certain regions of the continent, it remains significantly uneven. This disparity directly impacts digital inclusion, as mobile connectivity frequently serves as the primary means of accessing the Internet in regions where fixed broadband is scarce. However, subsequent analyses revealed that high mobile subscription rates do not necessarily correspond to high Internet usage, particularly when constraints such as data costs, digital literacy, and network quality persist.

The graph illustrates the potential of mobile technology to facilitate connectivity across Africa, as well as the challenges posed by the fragmentation of mobile penetration throughout the continent. While mobile networks are extensively deployed, particularly in urban areas, a considerable digital divide persists, necessitating the implementation of targeted policies, infrastructure investments, and digital literacy initiatives. The insights derived from this figure provide a critical baseline for the subsequent interpretation of analyses on Internet usage and clustering patterns.

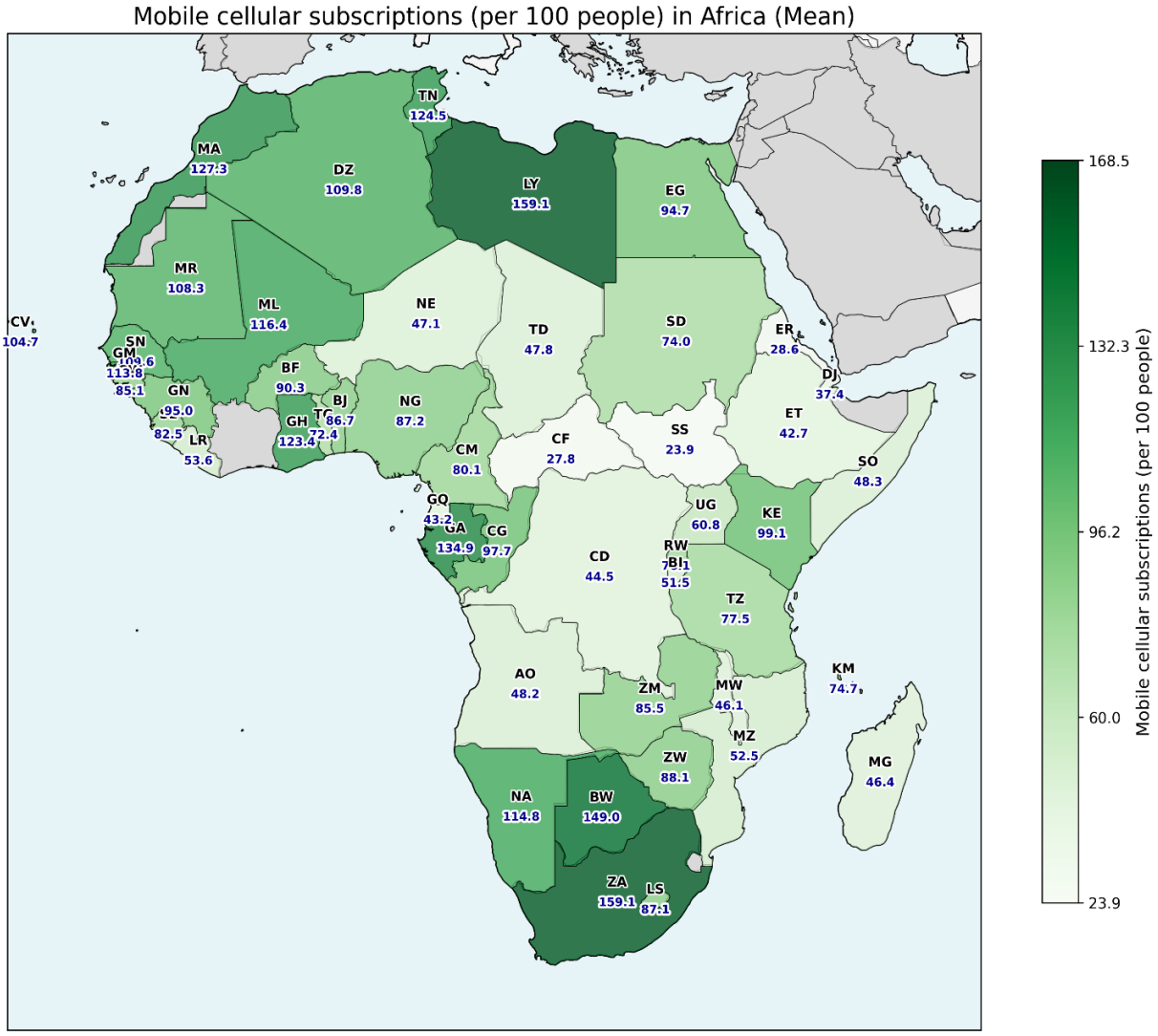



*Figure 7. Mobile Cellular Subscription by Using Mean 2014-2023*

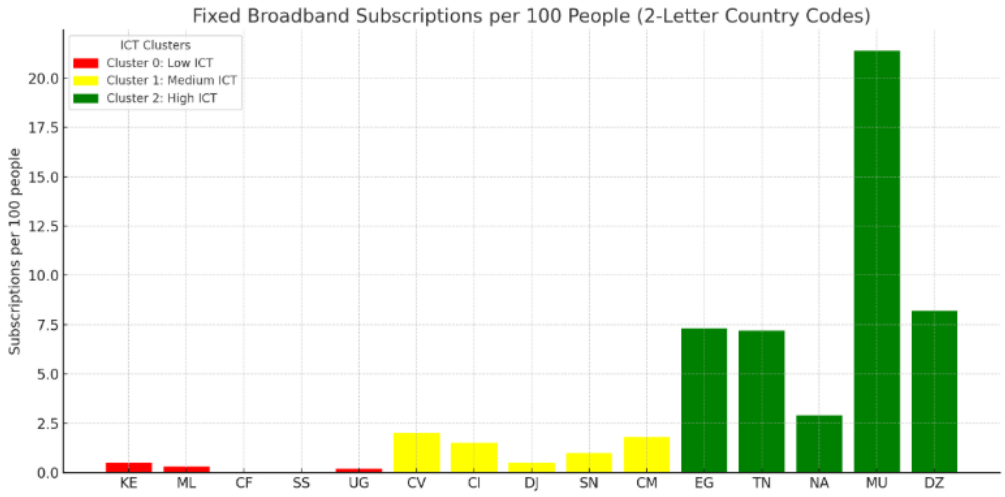
*Source: Author Creation*

The map in Figure 7 clearly shows distinct spatial patterns in mobile cellular subscriptions across the African continent. Countries with high subscription rates, such as Libya, South Africa, Botswana, Gabon, Tunisia, Morocco, and Namibia, are predominantly situated in the northern and southern parts of Africa. These regions are more urbanised, economically developed and benefit from better mobile network infrastructure and regulatory environments that support telecom investment and competition. This spatial clustering reflects a concentration of digital advancement in areas with stronger institutional capacity and infrastructure readiness.

It is clear that countries with low subscription levels, including South Sudan, the Central African Republic, Chad, Eritrea, and Burundi, are primarily located in Central and Eastern Africa. These regions face systemic barriers such as political instability, weak infrastructure, conflict, and lower income levels, all of which limit mobile penetration. These low-performing countries tend to be geographically clustered in fragile or landlocked regions, indicating shared infrastructural and economic constraints.

The spatial distribution indicates that mobile penetration is not random but is closely linked to regional development patterns. Countries which are geographically proximate to more developed nations (for example, Namibia, which is adjacent to South Africa, or Tunisia, which is near Algeria) may experience certain benefits from cross-border infrastructure synergies, labour mobility and trade flows. However, it is important to note that these benefits may also serve to exacerbate existing regional disparities. It is imperative to comprehend these spatial clusters to formulate efficacious policy responses at the regional level, with a view to promoting equitable digital development.

### 4.6.2 Fixed Telephone Subscriptions (per 100 people) in Africa (2014-2023)




*Graph 2. Fixed Telephone Subscriptions*

*Source: Author Creation*

Graph 2. A bar chart was generated to illustrate broadband access across Africa. The data presented is derived from a representative sample of fifteen countries, with five countries selected from each of the three ICT development clusters. The initial cluster, designated as Cluster 0, encompasses countries that exhibit minimal development in the field of ICT.

Cluster 1 comprises countries that demonstrate a medium level of ICT development, while Cluster 2 encompasses countries that exhibit a high level of ICT development. The average number of fixed broadband subscriptions per 100 people was calculated for each country from 2014 to 2023. As anticipated, countries within Cluster 2 demonstrated remarkably elevated subscription rates.

Noteworthy exceptions include Seychelles and Morocco, which are distinguished by their sophisticated broadband infrastructure. Conversely, countries classified as part of Cluster 0, including Burundi and Chad, exhibited minimal or near-zero broadband penetration, indicative of significant infrastructural and economic challenges. The countries classified as part of Cluster 1 exhibited intermediate levels of broadband access, suggesting that there has been some degree of progress; however, this progress is contingent upon continued investment and policy support. This chart underscores the digital divide that persists across the continent and highlights the strong association between ICT cluster classification and broadband availability.

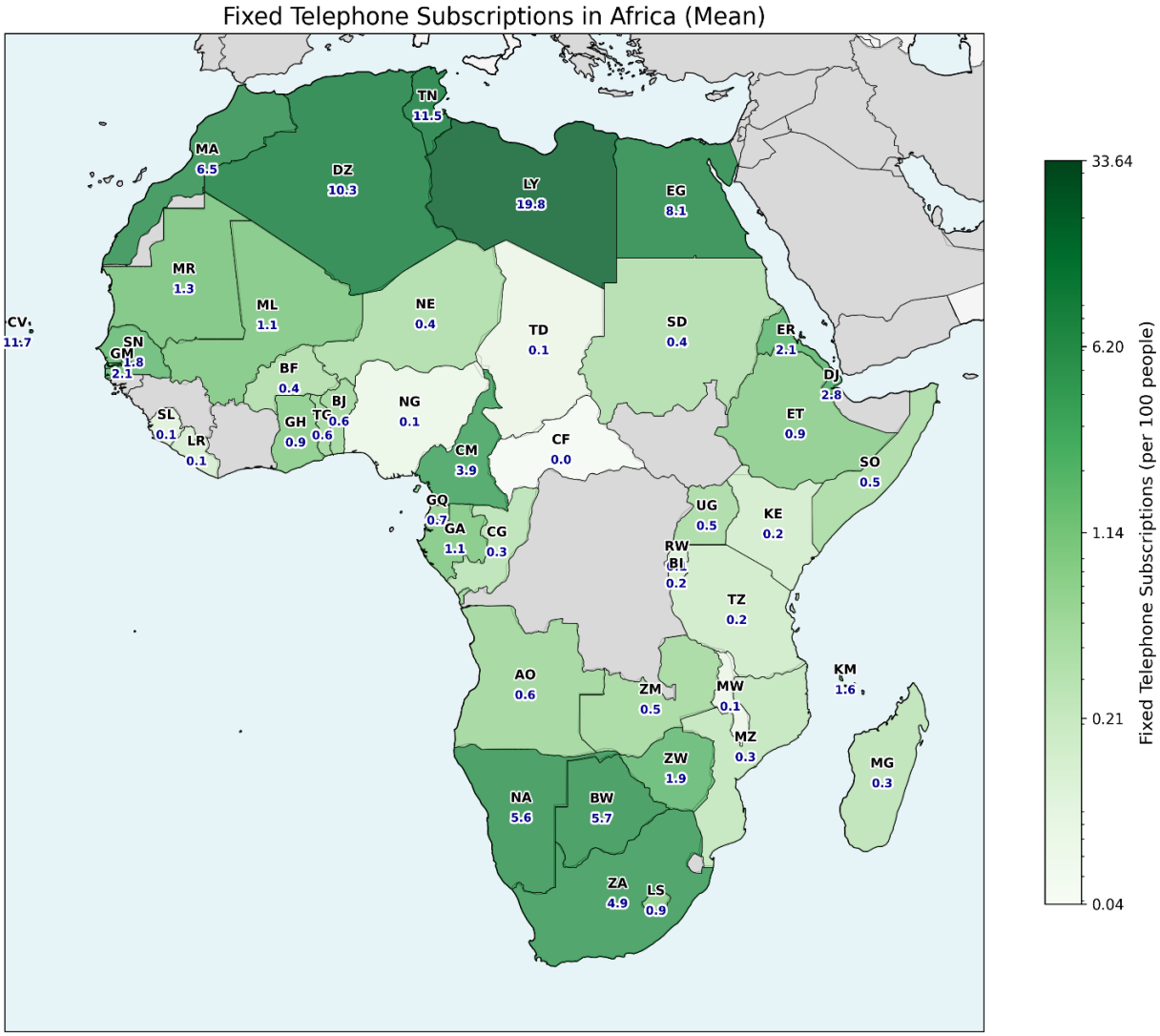



*Figure 8.Fixed Telephone Subscriptions (2022)*

*Source: Author Creation*

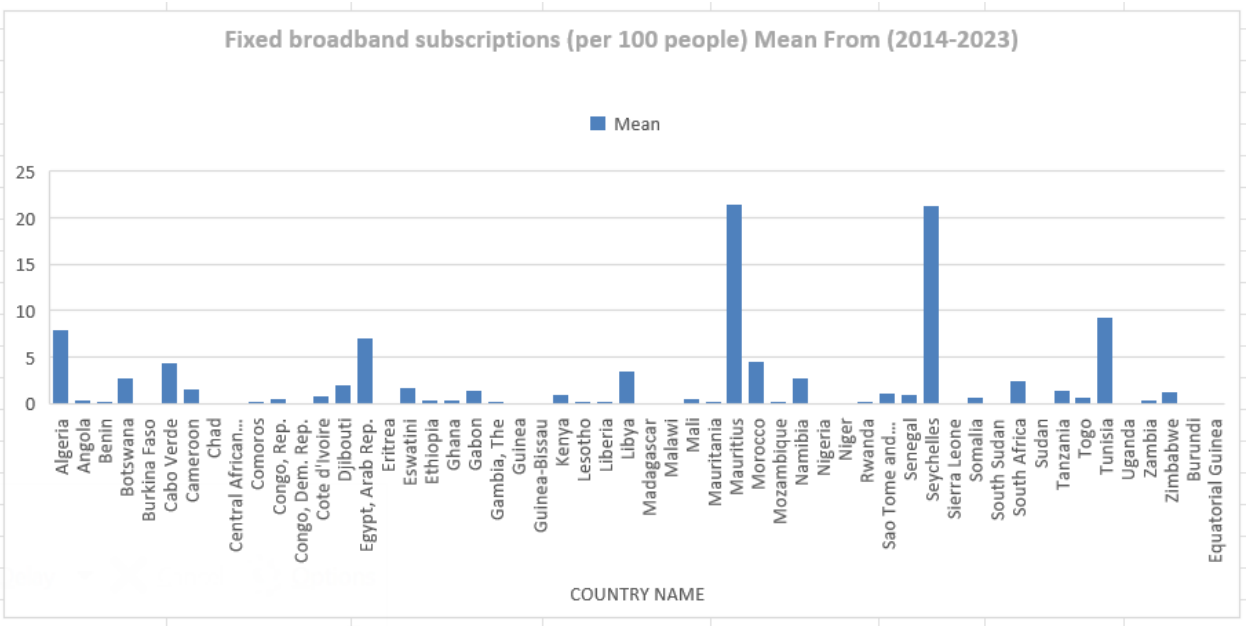
Conversely, most African countries exhibited average subscription rates that were consistently below 5 per 100 people. In numerous low-income or conflict-affected states, including Chad, Somalia, and South Sudan, the existing fixed-line infrastructure is either nonexistent or functionally obsolete. The advent of mobile networks has enabled these nations to circumvent the necessity of substantial investment in landline infrastructure, consequently leading to the underdevelopment of fixed telephone networks.

This discrepancy lends further credence to the prevailing hypothesis that mobile technology has supplanted fixed-line infrastructure in the majority of African regions. While landlines persist in a few upper-middle-income and island nations, they no longer delineate

communication access for most of the continent. Nevertheless, a high degree of fixed-line availability in some countries is associated with other forms of digital infrastructure, such as broadband or fibre-optic connectivity, which frequently utilise legacy telephone infrastructure as a foundation.

In essence, the provision of historical context is the primary function of this indicator. The shift from traditional to mobile-first connectivity strategies is best understood by examining the historical underpinnings of these changes. While fixed-line expansion has slowed or plateaued in most countries, its presence can still signal a higher baseline of infrastructure and may support more advanced forms of digital service delivery, particularly in urban and commercial centres.

### 4.6.3 Fixed Broadband Subscriptions (per 100 people) Mean From (2014-2023)




*Graph 3.Fixed Broadband Subscriptions (per 100 people) Mean From (2014-2023)*

*Source: Author Creation*

The above bar graph shows the average number of fixed broadband subscriptions per 100 people across African countries over a period of ten years. The graph demonstrates that fixed broadband remains limited in most parts of Africa, with the majority of countries exhibiting an average of fewer than five subscriptions per 100 people. This phenomenon is indicative of two interrelated challenges: firstly, the underdevelopment of infrastructure, and secondly, the predominance of mobile broadband over fixed-line connections on the continent.

However, a number of countries are distinguished by considerably higher subscription rates. Mauritius and Seychelles lead by a significant margin, with each country having over 20 fixed broadband subscriptions per 100 people. This is indicative of the advanced ICT infrastructure and high levels of service accessibility in these countries. Tunisia and Mauritania also demonstrate relatively strong performance, averaging approximately 9 and 7 subscriptions, respectively. Algeria, Botswana, and Libya follow with moderate rates between 4 and 7 subscriptions, suggesting a more developed fixed-line infrastructure compared to the continental average.

In contrast, the vast majority of African nations – including large and populous countries such as Nigeria, Ethiopia, Tanzania, and Uganda – register very low fixed broadband rates, often below 1 subscription per 100 people. This marked contrast underscores the persistent challenges in implementing fixed broadband infrastructure, particularly in rural and economically disadvantaged regions. The limited uptake of this technology is frequently attributed to several factors, including the high costs associated with installation, the limited availability of fibre-optic networks, the low rate of household computer ownership, and the cost-prohibitive nature of fixed-line services.

The graph shows an important part of Africa's digital development: mobile internet has grown quickly, but most people still can't get fixed broadband. Fixed broadband is usually more stable and faster, and is essential for businesses, institutions, and households that need a lot of internet capacity. So, it's really important that more people have access to fast internet at home. This will help grow digital economies, improve education and healthcare, and encourage new ideas. Governments and private companies need to invest in fiber-optic infrastructure, public-private partnerships, and affordable service models to make fixed broadband a viable and widespread option across the continent.

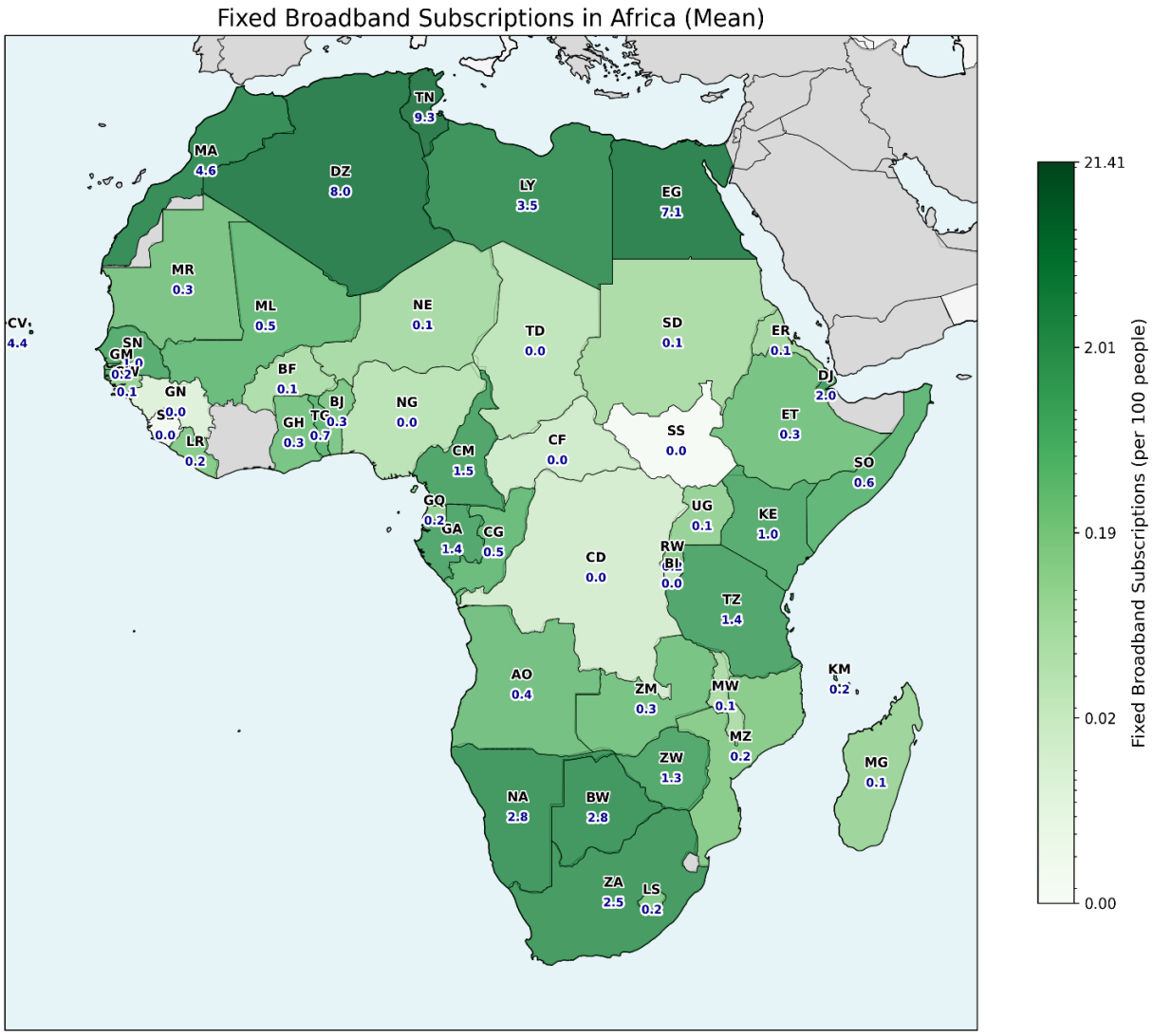



*Figure 9. Fixed Broadband Subscriptions in Africa Mean of 2014-2023*

*Source: Author Creation*

The map shows the average number of fixed broadband subscriptions per 100 people across African countries. The data is shown using a green colour scale, where darker shades indicate higher subscription rates. Fixed broadband is high-speed internet access through technologies such as DSL, cable, or fibre connections, typically used at home or work.

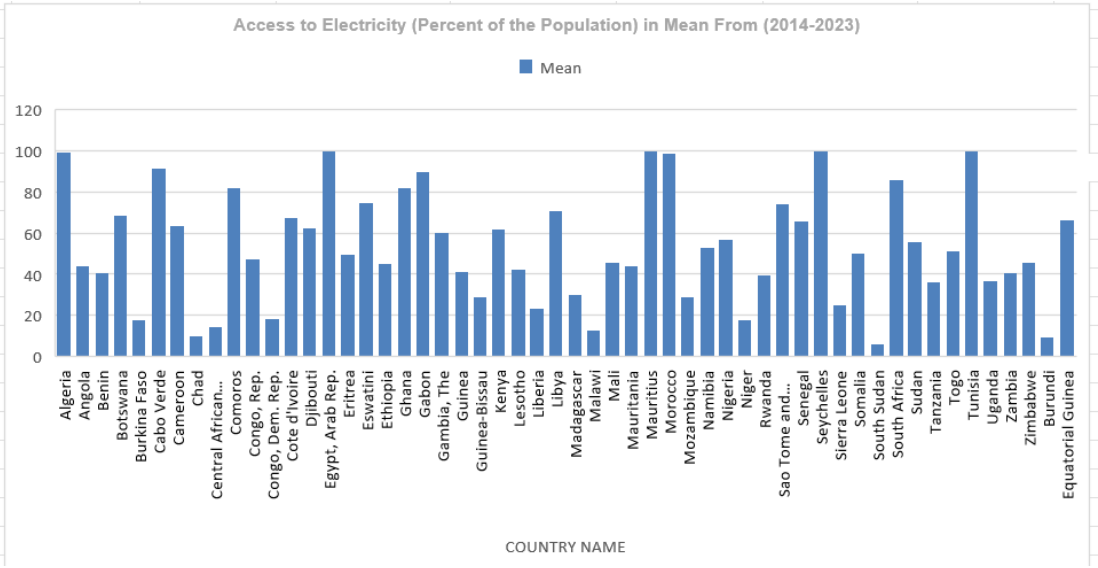
The map shows a big difference in internet access in Africa. Most African countries have very few people with internet at home. Most countries have fewer than 1 subscription for every 100 people. This is because they don't have good internet infrastructure, it's expensive, and most people use mobile networks to access the internet.

Some countries have higher subscription rates. Egypt (7.1), Tunisia (9.9), Libya (3.5), Algeria (8.0), Morocco (9.5), and South Africa (2.5) are among the top performers, reflecting better telecommunications infrastructure and urbanisation. In Southern Africa, Namibia and Botswana both report 2.8 subscriptions per 100 people, while Djibouti (2.0) is also high in the Horn of Africa.

In contrast, a significant number of countries, notably in Central and Sub-Saharan Africa, including Chad, the Central African Republic, South Sudan, and numerous others, report virtually no fixed broadband subscriptions. This underscores a significant constraint in terms of connectivity, especially for institutions or services that are reliant on stable, high-speed internet connections.

The map shows the continent's heavy reliance on mobile broadband for connectivity and the urgent need for investment in fixed broadband infrastructure to support long-term digital transformation, education, and economic growth.

### 4.6.4 Access to Electricity (percentage of the Population) in Mean From (2014-2023)




*Graph 4. Access to Electricity in Africa from 2014-2023*

*Source: Author Creation*

The bar graph illustrates the average percentage of the population in each African country that had access to electricity over ten years. The graph provides a clear picture of the significant disparities in electricity access across the continent. It is evident that certain countries, including Algeria, Egypt, Mauritius, Morocco, Seychelles, and Tunisia, have reported nearly universal access, with average values reaching or approaching 100%. This is indicative of robust national infrastructure, dependable energy supply systems, and consistent government investment in electrification.

As demonstrated by the evidence, other countries, including but not limited to Botswana, Cabo Verde, Gabon, Namibia, and South Africa, demonstrate relatively high access rates, generally ranging from 70% to 90%. This finding suggests the presence of robust, albeit not yet fully universal, energy coverage. These countries are frequently characterised by higher degrees of urbanisation and economic development, which in turn renders national electrification a more viable undertaking. Concurrently, a considerable proportion of African countries continue to exhibit low electricity access levels, with some of the lowest average electricity access recorded in Burundi, Chad, the Central African Republic, Malawi, South Sudan, and Niger. These nations typically encounter structural and financial impediments, including underdeveloped infrastructure, rural dispersion, inadequate public investment, and, in many cases, conflict or political instability.

A regional analysis of the data indicates that Northern and Southern Africa are most successful in ensuring access to electricity. In contrast, Central and Sub-Saharan Africa

continue to experience significant challenges related to widespread energy poverty. Island countries such as Seychelles and Mauritius also demonstrate high levels of access, a phenomenon that is likely attributable to their comparatively smaller geographic areas and more manageable population sizes. Conversely, densely populated or landlocked countries such as Uganda, Tanzania, and Ethiopia demonstrate a more varied picture, with rural areas exhibiting a significant lag in terms of urban centres. This persistent gap in electricity access has direct implications for development, as energy availability affects nearly all aspects of life, from health and education to economic growth and digital inclusion.

To summarise, although advancements have been observed in certain regions of the continent, the graph emphasises the pressing necessity for expedited investment in energy infrastructure, particularly in countries with limited access. It is imperative to recognise the significance of expanding grid coverage, promoting off-grid and renewable solutions, and ensuring affordability as pivotal steps in addressing the electricity access gap and attaining more equitable development outcomes across Africa.

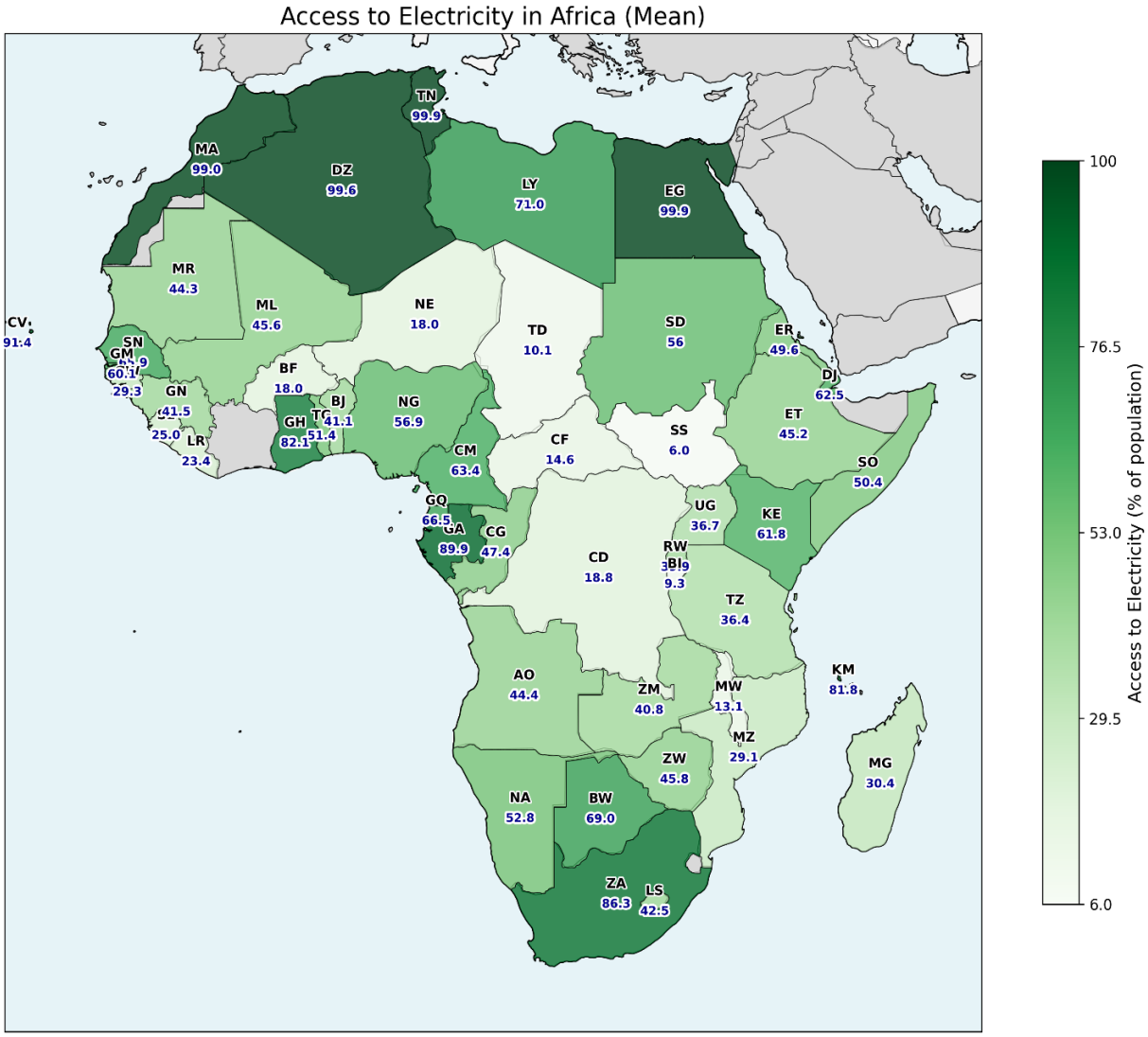



*Figure 10. Access to Electricity in Mean From 2014-2023*

*Source: Author Creation*

The map shows the average proportion of the population with access to electricity across African countries. Each country is colour-coded on a gradient from light to dark green, where darker shades indicate higher access rates. The values represent the percentage of the total population that has reliable access to electricity.

The map clearly shows that North African countries such as Algeria (99.6%), Egypt (99.9%), Libya (71%), Tunisia (99.8%), and Morocco (99%) have near-universal access to electricity.

High access rates are also observed in parts of Southern Africa, particularly in South Africa (86.3%), Botswana (69%), and Eswatini (88.9%).

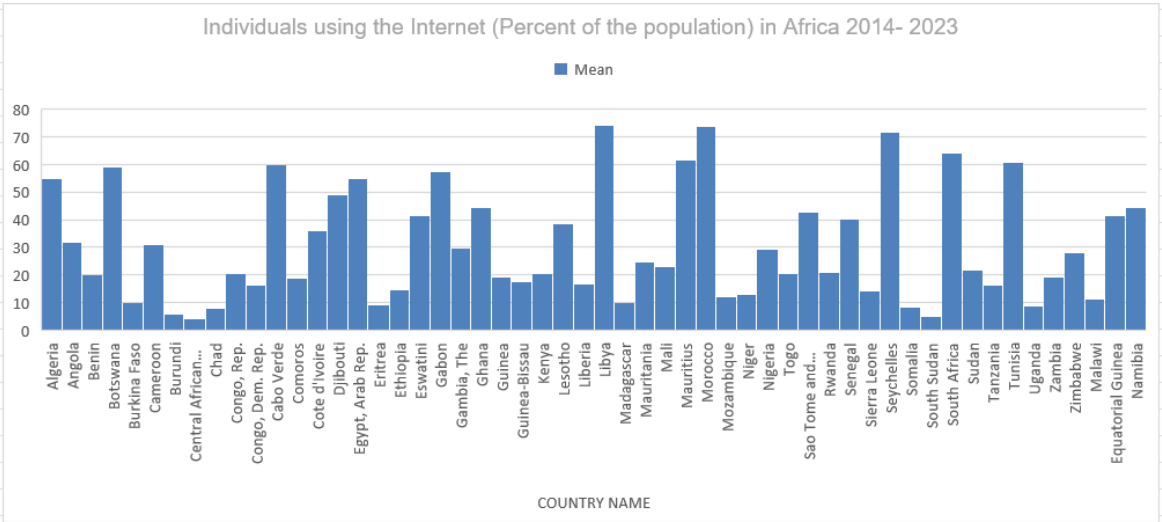
In contrast, several Central and Sub-Saharan African nations show significantly lower levels of access. Countries like Chad (10.1%), the Central African Republic (14.6%), Malawi (13.1%), Burundi (9.3%), and South Sudan (6%) have some of the lowest electrification rates on the continent. Deep infrastructural and socio-economic challenges are still limiting energy development in these regions.

The percentage of the population with access to electricity is indicated numerically. The map reveals a clear pattern: nations with higher ICT adoption, such as those in North and Southern Africa, generally enjoy broader electricity access, often exceeding 80%. In contrast, countries with low ICT adoption, particularly in central and parts of east and west Africa, have significantly lower rates of electricity access. This visual clearly shows the strong link between technological development and infrastructure availability across the continent.

East Africa displays a mixed pattern. Kenya (61.8%) and Ethiopia (45.2%) show moderate access levels, while others like Rwanda (9.3%) and Uganda (36.7%) still lag. In West Africa, the electrification rate varies considerably. Ghana (82.5%) and Senegal (69.1%) have relatively high rates, whereas countries like Niger (18%), Liberia (23.4%), and Guinea (25%) fall on the lower end of the spectrum.

This geographic disparity in electricity access highlights a persistent development gap, particularly between northern and southern regions compared to central and interior parts of the continent. Improving access to electricity is crucial for advancing socio-economic development, healthcare, education, and digital connectivity in Africa.

### 4.6.5 Individuals using the Internet (percentage of the population) in Africa 2014- 2023



*Graph 5. Individuals Using the Internet in Africa 2014-2023*

*Source: Author Creation*

The bar graph, entitled Individuals using the Internet (percentage of the population) in Africa 2014–2023, presents the average percentage of people using the Internet in each African country over the last decade. The graph reveals significant disparities in digital access across the continent, highlighting both regional progress and persistent challenges. Notably, countries such as Libya, Morocco, Seychelles, and Tunisia have particularly high internet penetration, with each exceeding 70% of the population. The countries have experienced considerable economic development, enhanced telecommunications infrastructure, and government policies that facilitate digital transformation. The examples of South Africa and Cape Verde, with averages above 60%, demonstrate how investment in mobile networks and the reduction in the cost of internet access can lead to increased connectivity, even within diverse economic contexts.

In the mid-range, countries such as Algeria, Botswana, Egypt, Gabon, Ghana, Mauritius, Namibia, and Kenya report moderate internet usage between 40% and 60%. These countries are frequently distinguished by expanding urban populations and growing mobile internet services, although rural and low-income communities may encounter obstacles to access. Conversely, the graph reveals a conspicuously low level of internet usage in several nations, notably in Central and East Africa. It is evident that some countries, including Burundi, the Central African Republic, Chad, Eritrea, Somalia, and South Sudan, have an average internet access rate of less than 20%. This is indicative of the repercussions of economic disadvantage, persistent conflict, inadequate infrastructure, and the paucity of government support for the development of ICT. In these regions, significant demographic groups continue to be marginalised due to their digital exclusion, which has far-reaching consequences for their socio-economic and cultural empowerment, including restricted access to educational and employment opportunities, as well as to communication channels and essential public services.

The difference between countries is also clear. In northern and southern Africa, more people use the internet than in central and some western countries.

Interestingly, island nations like Seychelles and Cape Verde do well, probably because they have smaller populations and their ICT development strategies are focused. The graph shows that there is a big digital divide in Africa. This means that not all parts of the continent are doing as well as other. Many people in Africa still can't get online. To bridge this gap, we need to work together to invest in digital infrastructure, make it cheaper, improve digital skills, and implement policies that help all communities, especially those that are underserved and rural. This will allow the continent to take advantage of the social and economic opportunities that come with digital connectivity.

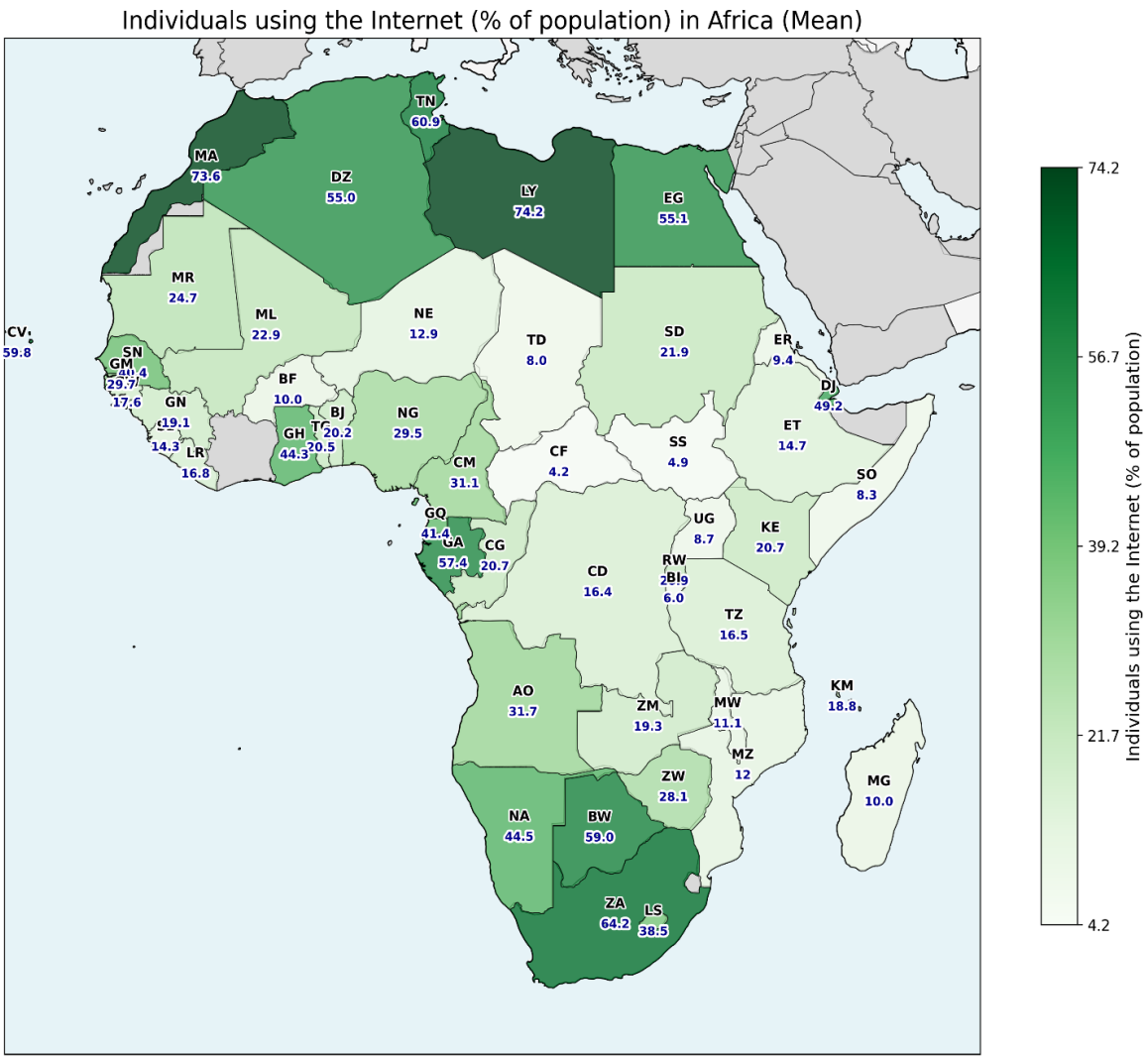



*Figure 11. Map of Individuals Using the Internet in Africa 2014-2023*

*Source: Author Creation*

This map shows the average percentage of people using the Internet across African countries. The shading intensity reflects the proportion of the population with internet access – darker green areas indicate higher usage rates, while lighter green areas show lower levels of internet penetration. Countries with no available data are shown in grey. The map titled Individuals using the Internet (percentage of population) in Africa (Mean) provides a clear visual representation of the average proportion of the population in each African country that uses the Internet. The countries are shaded from light to dark green, with darker shades indicating higher levels of internet penetration. The map clearly shows the regional disparities across the continent. Northern African countries such as Libya (74.2%), Morocco (73.6%), Tunisia (60.9%), and Egypt (55.1%) exhibit some of the highest internet usage rates, alongside South

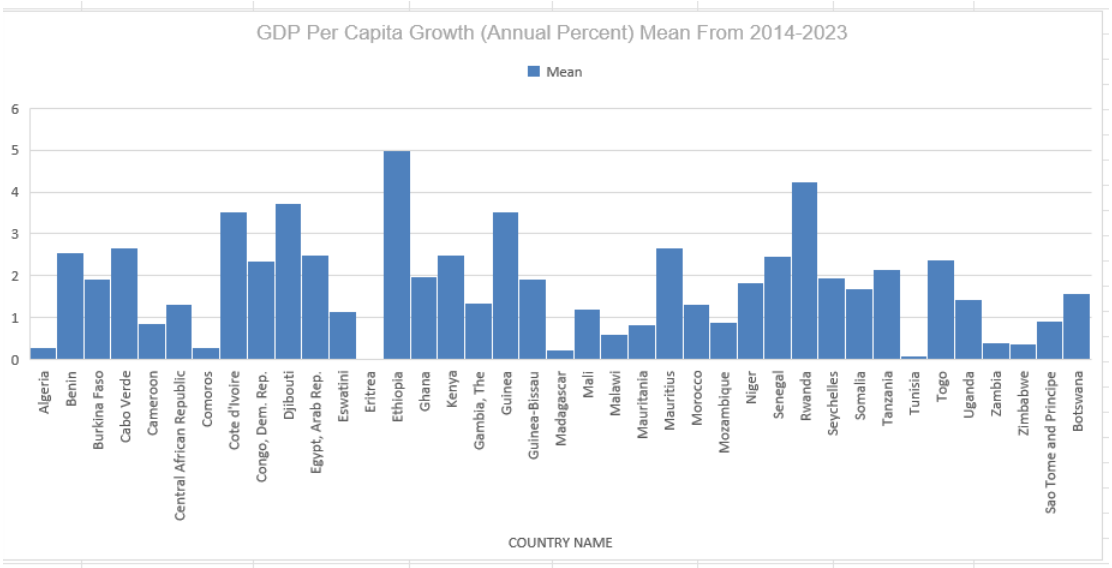
Africa (64.2%) and Botswana (59%) in the south. These nations have better ICT infrastructure, more urban development, and greater economic capacity to support widespread internet access. In contrast, much of Central Africa and several Sahelian and East African countries display notably lower rates. For instance, Chad (8%), the Central African Republic (4.2%), and South Sudan (5.5%) are among those with the lowest connectivity, due to infrastructural challenges, lower investment in digital services, and economic limitations. The map shows that coastal and more urbanised nations outperform landlocked or conflict-affected ones in terms of internet access. Visualisation highlights the digital divide within Africa and proves the need for targeted efforts to expand internet access in underserved regions.

In contrast, central parts of eastern Africa show significantly lower levels of internet usage. Countries such as Chad, Niger, South Sudan, and the Democratic Republic of the Congo are categorized as low performers, indicating limited internet penetration. This can be attributed to infrastructural underdevelopment, low literacy and digital skill levels, and broader socioeconomic challenges that inhibit connectivity, particularly in rural and underserved areas.

Several countries in west Africa present a more mixed picture. While the Ivory Coast, Senegal, and Ghana have medium to high levels of internet usage, their neighbouring countries, such as Guinea and Burkina Faso, have lower levels. This variability illustrates how national policy frameworks, data affordability, and educational systems significantly influence digital adoption rates, even among geographically proximate nations.

It is imperative to acknowledge that the grey-shaded regions on the map denote countries for which data were either unavailable or incomplete in the 2020 World Bank dataset. These discrepancies are indicative of deficiencies in reporting infrastructure and broader issues of statistical capacity in some fragile or conflict-affected states.

### 4.6.6 GDP Per Capita Growth (Annual%) Mean From 2014-2023




*Graph 6. GDP Per Capita Growth (Annual%) Mean From 2014-2023*

*Source: Author Creation*

The bar graph shows the average yearly increase in GDP per person in different African countries over ten years. The GDP per capita growth rate shows how fast the money a country has per person is going up, after considering any changes in the population. It is a very important measure of how well the economy is doing and how it is developing.

According to the graph, Ethiopia is the best at this, with an average growth rate of about 5% each year. This strong performance is in line with Ethiopia's recent efforts to develop its infrastructure, invest in energy and transport, and rapidly expand its cities, despite facing economic and political challenges in recent years. Other countries with relatively high average growth rates include Rwanda, Djibouti, Côte d'Ivoire, Senegal, and Guinea, all showing annual growth rates between 3% and 4%. This shows that their economies are growing strongly. This is because they have made big changes to the way their economies are run, invested in services and industry, and improved how they govern themselves.

Kenya, Ghana, Benin, Burkina Faso, Tanzania, and Tunisia are all growing at a moderate rate of around 2-3%. These countries have seen their economies grow steadily, often because they have more than one source of income, their farming is more modern, and their digital sectors are growing. However, even though the economy is growing, many people still face challenges such as unemployment, rising prices, and unfairness. These things stop the economy from making a real difference in people's lives.

Some countries have an annual GDP per capita growth rate of less than 2%. These include Zimbabwe, Zambia, Madagascar, Mozambique, Egypt, and Cameroon. The reasons for this

are different, and include things like unstable money, debt, conflict, big changes in the prices of goods, or slow changes to the way the economy is run. Countries like the Central African Republic and Sudan, which are not shown on this graph but often perform poorly in such metrics, face deeply rooted economic problems.

Overall, the graph shows a mixed economic picture across Africa. While many countries are experiencing significant growth, this is not always shared equally, and weak economies are still easily affected by outside events. To keep growing the economy, we need to invest in people, good governance, infrastructure, technology, and trade between regions. This will make the economy stronger and include more people.

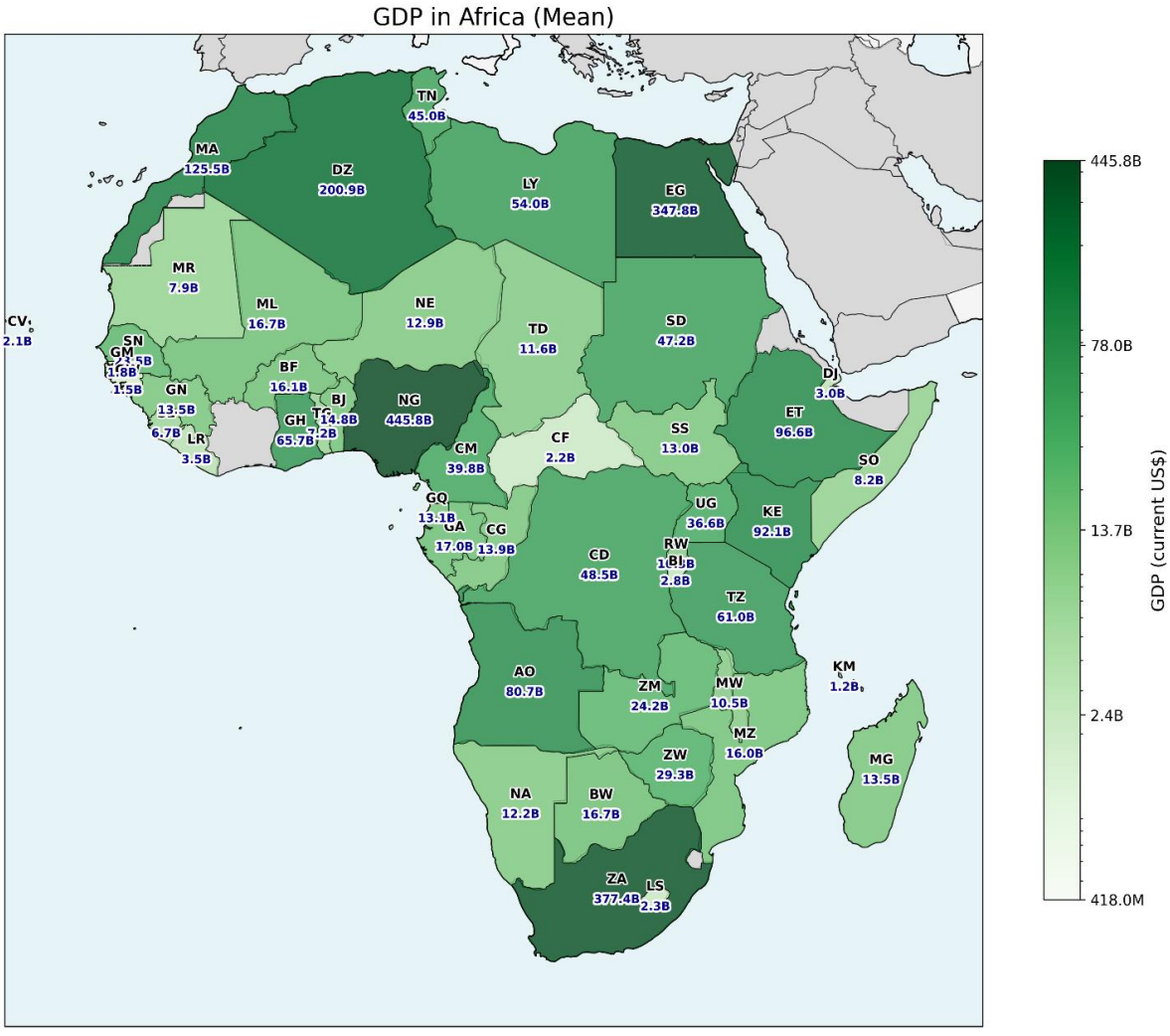



*Figure 12. GDP Per Capita Growth (Annual%)*

*Source: Author Creation*

The map shows the average GDP of African countries, measured in current US dollars. Each country is shaded in different shades of green, with darker shades showing higher GDP values. The GDP figures are listed for each country, making it easy to compare how big each country's economy is.

Some Northern African countries, like Egypt, Algeria, and Morocco, have some of the highest GDPs. This is shown by the dark green shades on the map. Nigeria has the largest GDP in Africa, followed by South Africa and Egypt. In contrast, many central and smaller island nations, such as Comoros and São Tomé and Príncipe, have much lower GDPs. These nations are represented by lighter green hues.

This image clearly shows the big differences in wealth between different parts of the continent. While a few countries have very high GDPs, most countries have relatively low GDPs. The map clearly shows the different economic strengths of the countries in Africa. It highlights both the countries with larger economies and the countries with smaller economies.

# 5 KEY FINDINGS AND POLICY RECOMMENDATIONS

## 5.1 Discussion of Key Findings

The findings from the data analysis underscore substantial disparities in ICT utilisation across African countries, shaped by infrastructural, economic, policy, and human capital dimensions. The analysis revealed that mobile cellular subscriptions are widespread, with some countries exceeding 150 subscriptions per 100 people. However, it should be noted that high subscription rates do not necessarily equate to digital inclusion. In a number of contexts, the use of dual SIM cards and the presence of fragmented network coverage can obfuscate the true extent of internet usage and digital service access.

A critical correlation was identified between internet usage and electricity access ($r = 0.87$), thereby reinforcing the notion that foundational infrastructure is a prerequisite for meaningful digital engagement. Additionally, human capital and literacy rates were found to be moderately to strongly correlated with broadband adoption and internet use. For instance, the HCI exhibited a robust relationship with fixed broadband ($r = 0.82$) and internet usage ($r = 0.73$), suggesting that the development of Information and Communication Technologies (ICT) is closely intertwined with educational and workforce capacity.

Despite its low explanatory power ($r = 0.0877$), the regression analysis signalled the complexity of digital inclusion, indicating that socioeconomic and infrastructural variables alone cannot fully predict internet adoption. A multifaceted interplay of affordability, regulatory environments, and social factors, largely qualitative and context-specific, exerts a profound influence on shaping digital behaviour.

The subsequent cluster analysis further delineated African countries into three distinct ICT development groups. The initial cluster, designated as Cluster 0, encompasses countries exhibiting low ICT indicators. These nations face challenges characterised by limited electricity, underdeveloped broadband infrastructure, and constrained economic capacity. Cluster 1 encompasses nations that demonstrate an improvement in their ICT profiles, albeit in an inconsistent manner. Conversely, Cluster 2, under the leadership of Mauritius, exemplifies a comprehensive digital maturity that is bolstered by policy innovation, economic stability, and robust infrastructure. These clusters provide a comparative framework for understanding relative performance and prioritising interventions.

## 5.2 Discussion of Research Questions

**1.** What are the current levels of ICT development and digital adoption across African countries, based on standardised, internationally recognised indicators?

The study provides a comparative analysis that utilises internationally standardised indicators, including mobile cellular subscriptions, internet penetration, fixed broadband

subscriptions, and the HCI. The analysis reveals substantial disparities among nations: while certain countries demonstrate high levels of mobile subscription and internet access, others lag significantly below global benchmarks. The indicators were compiled from various sources, including the World Bank and the ITU, thereby ensuring international validity. Descriptive statistics and correlation matrices were used to assess development levels, revealing both progress and persistent digital divides.

2. How do national ICT policies and implementation strategies differ between high-performing and low-performing African countries, and what patterns of effectiveness can be identified?

The exploration of patterns in policy effectiveness was conducted through a dual approach, incorporating both qualitative and quantitative methodologies. High-performing countries such as Mauritius and South Africa typically exhibit the following characteristics: strong regulatory environments, robust infrastructure, and forward-looking ICT strategies that are aligned with education, economic policy, and innovation. Conversely, low-performing countries frequently exhibit a paucity of cohesive frameworks or encounter deficiencies in implementation due to inadequate institutional capacity. The discourse in Chapter 5 underscores these discrepancies, citing national policies, regional initiatives, and performance metrics. The effective implementation of policy patterns necessitates the integration of human capital development, public-private partnerships, and inclusive access strategies.

3. Do clusters of countries with similar levels of digital readiness emerge, and what structural, economic, or policy characteristics define these clusters?

The application of cluster analysis in Chapter 4.4 identified three distinct groupings of African countries based on their ICT indicators. The initial cluster, designated as Cluster 0, encompasses countries that exhibit extremely limited access to and inadequate infrastructural capabilities in the realm of ICT. Cluster 1 comprises nations that demonstrate moderate levels of digital readiness and considerable growth potential. Finally, Cluster 2 comprises a select group of digitally mature countries that exhibit robust policy alignment and advanced infrastructure. The utilisation of structural variables, including electricity access, educational attainment, and GDP per capita, has been instrumental in elucidating the disparities among the clusters. This has served to substantiate the efficacy of clustering as a mechanism for policy differentiation and regional benchmarking.

4. What key factors enable or inhibit Africa's inclusive and sustainable ICT development?

A correlation analysis and policy review revealed multiple enablers and barriers. The enabling factors for achieving this goal include a reliable electricity supply, access to broadband internet, strong digital literacy skills, inclusive ICT strategies, and effective regional cooperation. The identified inhibitors include affordability barriers, a lack of skilled human capital, fragmented policies, and inadequate infrastructure, particularly in rural areas. The policy recommendations enumerated in this chapter are designed to address these factors by proposing actionable solutions, including the expansion of infrastructure, the promotion of affordability, the development of digital skills, and the strengthening of policy and regulatory frameworks.

## 5.3 Insights from Country Groupings

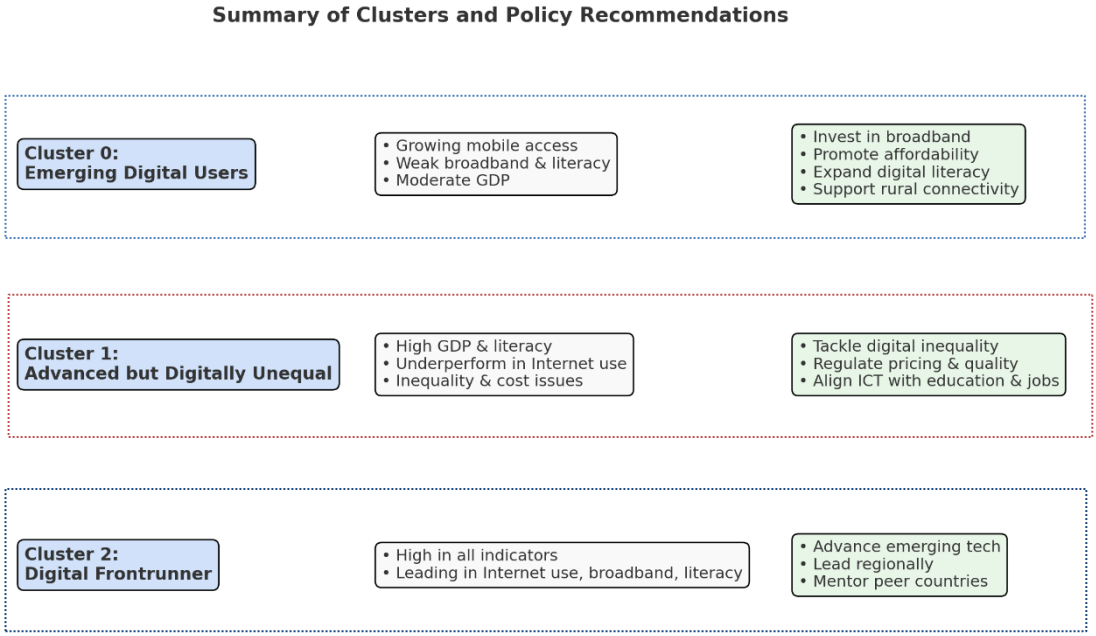



*Figure 13. Summary of Clusters and Policy Recommendations*

*Source Author Creation*

The clustering exercise provides valuable insights into the differentiation of policies. Countries in Cluster 0, including Chad and South Sudan, face systemic limitations in infrastructure and human capital, which hinder basic ICT access. Policies in these regions must prioritise foundational investments, particularly in the areas of electricity, education, and mobile broadband networks. These countries may also benefit from development assistance and concessional financing to bridge structural gaps.

The countries comprising Cluster 1, such as Ghana and Kenya, have demonstrated an enhancement in their ICT capacity. However, these nations continue to grapple with the persistent disparity in access between urban and rural regions. For these nations, the scaling

of successful pilot programs (e.g., Kenya's e-learning platforms or Ghana's teacher training programs) and the enhancement of cross-sector ICT integration will be pivotal. Strategies devised for the promotion of these goals must prioritise affordability, the development of rural infrastructure, and the cultivation of inclusive digital literacy.

Cluster 2 countries, though limited in number, illustrate that African nations can spearhead digital transformation through effective policy alignment, targeted investment, and regional collaboration. Mauritius has emerged as a paradigm of regulatory efficiency and comprehensive broadband coverage.

## 5.4 Policy Recommendations

The disparities in ICT utilisation across African countries, as previously discussed, underscore the necessity for targeted policy interventions. While certain nations have demonstrated notable progress in the realm of ICT development, others have encountered challenges due to deficiencies in their infrastructure, limited human capital, and inadequacies in their policy frameworks.

The subsequent policy recommendations are derived from the preceding analysis and findings. The following policy recommendations are proposed to foster inclusive, sustainable, and effective ICT development across Africa. These recommendations aim to provide actionable steps for governments, regional bodies, and stakeholders to enhance ICT infrastructure, accessibility, and utilisation across the continent.

**Recommendation 1. Invest in Basic Infrastructure**

The objective is to establish a reliable ICT infrastructure that serves as the backbone for digital services and applications across Africa [10].

A substantial impediment to the adoption of ICT in numerous African nations is the absence of fundamental infrastructure, such as reliable electricity, broadband networks, and data centres. Absent these foundational elements, endeavours to promote the utilisation of ICTs are prone to encounter significant challenges. [5].

**The following are proposed actions:**

**A. Proposed Actions to Expand Electricity Access**

- It is imperative to implement strategies that facilitate the expansion of electricity access.
- The implementation of rural electrification programs is imperative to ensure that even remote areas have access to reliable power [10].

**B. The Development of Broadband Infrastructure is Imperative.**

- Investing in the expansion of fibre-optic networks is a strategy that has been demonstrated to improve internet connectivity.
- The establishment of public-private partnerships to fund and manage broadband projects is a crucial aspect of modern infrastructure development [25].

**C. The Establishment of Data Centres is Critical.**

- The establishment of regional data centres has been identified as a strategy to mitigate latency and enhance data governance.
- The provision of incentives for private sector investment in data storage and processing facilities is a crucial aspect of the broader economic strategy [4].

**D. Mobile Network Coverage**

- It is imperative to provide support for the deployment of mobile towers in areas that are underserved with the objective of increasing coverage.
- The allocation of financial resources to reduce the cost of mobile devices and services for populations with limited financial means is a strategy that merits consideration [14].

**The Results will be.**

- The hypothesis that better connectivity enhances economic activities is supported by empirical evidence [65].
- The country has experienced an influx of foreign investment, which can be attributed to the enhancement of its ICT infrastructure.
- The concept of strengthened resilience is employed to denote the state of being more resilient against cyber threats and data breaches.

By prioritising investments in foundational infrastructure, African countries can create an enabling environment for ICT development, bridging the digital divide and fostering inclusive economic growth.

The term foundational infrastructure is understood to encompass essential components, including reliable electricity, broadband networks, data centres, and mobile connectivity. These elements are critical for supporting digital technologies that drive economic development, innovation, and social inclusion [4].

**Recommendation 2. To Enhance Affordability and Accessibility**

The objective is to eliminate the financial and systemic barriers to ICT access, thereby ensuring that all individuals, regardless of income, geographical location, gender, or disability, can benefit from digital technologies [10].

While the development of infrastructure is of paramount importance, affordability and accessibility persist as substantial challenges in numerous African nations. The high cost of devices and data services, as well as the limited digital literacy of the population, are factors that hinder the widespread adoption of ICTs. Addressing these issues is crucial to bridging the digital divide and promoting inclusive economic growth [71].

**The following are proposed actions**

**It Might Be Beneficial to Explore the Possibility of Implementing Targeted Subsidies and Tax Incentives**.

- Governments should consider reducing or eliminating taxes and import duties on ICT devices and services to lower costs for consumers.

- Addressing digital inequity, subsidies have been implemented as a policy measure to facilitate the acquisition of devices and the utilisation of Internet services by low-income households.

**The Promotion of Competitive Markets**

- The promotion of a competitive environment among service providers has the potential to yield enhanced services at reduced costs.
- To prevent monopolistic practices and ensure fair pricing, regulatory frameworks should be strengthened [71].

**The Development of Community Access Points**

- The establishment of public Internet access centres, particularly in rural and underserved regions, can facilitate affordable access to ICT services.
- These centres have the potential to function as hubs for digital literacy training and support [10].

**The Enhancement of Digital Literacy Programs**

- Investing in educational and training programs to enhance digital competencies will empower individuals to utilise ICT effectively.
- Collaborations with academic institutions and Non-Governmental Organisations (NGOs) can facilitate the implementation of these programs [10].

**We will be looking at Some Real-Life examples and Local Projects.**

- World Bank's Digital Economy for Africa (DE4A) Initiative: This initiative has supported changes to rules and investments to make ICT services cheaper and easier to access across the continent.
- ITU's Africa Region Initiatives 2023–2025: These initiatives focus on promoting inclusive digital communities by assessing and enhancing ICT accessibility in the African region.

**Expected Results:**

- The increased adoption of ICT services among low-income and marginalised populations is a significant development that warrants further investigation.
- The enhancement of economic opportunities is achieved through the facilitation of improved access to digital markets and services.
- The digital divide has been shown to be a contributing factor to social and economic disparities. Therefore, reducing the digital divide can be a strategy to promote equitable social and economic development.

The implementation of these measures by African countries has the potential to achieve substantial progress in ensuring the affordability and accessibility of ICT services, thereby fostering inclusive growth and development [14].

**Recommendation 3. The Development of Human Capital and Digital Skills.**

The objective is to provide individuals across Africa with essential digital competencies, ranging from basic literacy to advanced technical skills, with the ultimate aim of fostering an inclusive digital economy and enhancing employability.

The ongoing digital transformation in Africa offers both opportunities and challenges. Digital technologies have been demonstrated to have the capacity to stimulate economic growth and social development. However, the dearth of digital skills among the population presents a substantial impediment to these processes. The World Bank asserts that digital competencies represent one of the five fundamental pillars of the DE4A initiative. These competencies are deemed crucial for the mobilisation of digital innovations, which are believed to play a pivotal role in the transformation of African economies and societies [80].

Furthermore, the ITU underscores the importance of enhancing digital competencies to bridge the global digital divide. The underdeveloped technological capacities and skills of the populace in developing countries are the primary factors contributing to the underutilization of the Internet in these regions. The absence of these capacities and skills hinders individuals from leveraging the benefits that online services can offer.

**The following are proposed actions:**

**Include Digital Skills in Formal Education**

- Curricula at all educational levels must undergo a comprehensive revision to incorporate essential competencies such as digital literacy, coding, and information technology.
- It is imperative to equip and train educators with the necessary skills to deliver digital skills education effectively [37].

**Establishment of Public-Private Partnerships**

- It is imperative to involve private sector stakeholders in the design and implementation of digital skills programs.
- The utilisation of corporate social responsibility initiatives for funding training programs is a strategy that merits consideration [25].

**The Implementation of the National Digital Skills Framework**

- The development of comprehensive frameworks is imperative, delineating the digital competencies requisite at various levels.
- These frameworks should be utilised to guide the development of curricula, training programs, and assessment methods.

**Expected Results:**

- The employment sector has seen notable improvements in terms of employability and productivity across various sectors.
- The advent of innovation and entrepreneurship is propelled by a digitally proficient workforce.
- The digital divide has been shown to be a contributing factor to economic disparities. Therefore, policies aimed at narrowing this gap can potentially promote inclusive economic growth.
- The capacity to adapt to technological advancements and disruptions has been strengthened.

African countries must cultivate a robust human capital base endowed with essential digital skills, thereby positioning themselves to thrive in the modern economy. Investing in human capital is not only a moral imperative but also a strategic necessity for sustainable development and global competitiveness. The development of human capital and digital skills can help African nations bridge existing gaps, foster inclusive economic growth, and position themselves as competitive players in the global digital landscape [80].

**Recommendation 4. Make Stronger ICT Policy Frameworks.**

Inclusive ICT policy frameworks that foster innovation, ensure regulatory clarity and promote sustainable digital transformation across Africa.

Robust ICT policy frameworks are imperative for the direction of digital transformation, the attraction of investment, and the assurance of equitable access to digital services. In many African countries, the digital economy is stifled by outdated or fragmented policies. The reinforcement of these frameworks is instrumental in ensuring the effective harnessing of technological advancements, the mitigation of risks, and the widespread dissemination of the advantages of digitalisation [64].

**The following are proposed actions:**

**The Development of Comprehensive National ICT Policies**

- National ICT policies must be formulated or updated in a manner that reflects contemporary technological trends and socio-economic objectives.
- It is imperative to ensure that policies encompass areas such as broadband development, cybersecurity, data protection, and digital inclusion [14].

## Imperative to Fortify Regulatory Institutions

- To augment the capacity of regulatory bodies to enforce ICT policies with utmost efficacy.
- To furnish regulators with the necessary training and resources to ensure they can maintain a level of proficiency that aligns with the accelerating pace of technological advancements [14].

## Implementation of Monitoring and Evaluation Mechanisms

- The establishment of clear indicators and benchmarks is imperative for the assessment of the effectiveness of ICT policies.
- It is imperative to undertake systematic, periodic reviews of established policies, accompanied by the requisite adjustments, with these revisions being informed by empirical evidence derived from performance data and by an acute awareness of the evolving needs of the organisation [25].

**Case Studies**

**Kenya's ICT Policy Framework:**

The Republic of Kenya has developed a comprehensive ICT policy framework and implementation strategy. This strategy is complete with measurable outcomes and time frames, thereby demonstrating effective policy planning and execution.

**The HIPSSA Project** is a research initiative that focuses on the intersection of health, information technology, and social sciences.

The objective of the Harmonisation of ICT Policies in Sub-Saharan Africa (HIPSSA) project is to cultivate a robust, interconnected, and sustainable communications sector through the harmonisation of policy, legal, and regulatory frameworks at regional and continental scales [81].

**Expected Results:**

- The enhancement of coherence and adaptability of ICT policies is conducive to the development of a more favourable environment for digital innovation.
- The enhancement of regulatory clarity has been demonstrated to have a positive impact on investment attraction and the fostering of competition within the ICT sector.
- A more profound congruence between national policies and regional and international standards is imperative to enable cross-border digital initiatives.
- It is imperative to enhance stakeholder engagement to guarantee that ICT policies are inclusive and responsive to the requirements of all societal segments.

**Recommendation 5. Fostering Inclusive Digital Economies**

The digital transformation across African nations must be inclusive, equitable, and accessible to all segments of the population. This is the only way to ensure sustainable economic growth and social development.

Digital technologies offer significant opportunities for economic advancement; however, disparities in access and utilisation can amplify existing inequalities. An inclusive digital economy is imperative to ensure that marginalised groups, including women, rural populations, and persons with disabilities, are not left behind in the digital revolution. By cultivating inclusivity, nations can leverage the full potential of digital technologies to drive comprehensive development.

**The following are proposed actions:**

**Implementation of Targeted Policies for Marginalised Groups**

- The development and enforcement of policies that specifically address the digital needs of marginalised communities is imperative.
- It is imperative to incorporate these policies into national digital strategies and development plans [14].

**Promote Gender Equality in Digital Access**

- Addressing the gender gap in digital access necessitates the implementation of initiatives that empower women and girls with digital skills and resources [82].
- Collaborations with organisations such as the GSMA's Connected Women program can facilitate the exchange of best practices and resources, thereby enhancing the efficacy of the program [82].

**Case Studies**

**GSMA's Connected Women Program:**

This initiative is designed to bridge the gender gap in mobile internet and mobile money services in low- and middle-income countries. It provides clear policy recommendations and actively supports stakeholders in implementing strategies to promote digital inclusion for women [82].

**Expected Results:**

- The present study posits that there is an increased participation of marginalised groups in the digital economy.
- A reduction in the digital divide has been observed across various demographics and regions.
- This study hypothesises that enhanced economic growth will be driven by a more inclusive and diverse digital workforce.
- The pursuit of enhanced social equity and empowerment is facilitated by ensuring equitable access to digital resources and opportunities [10].

**Recommendation 6. The Promotion of Regional Cooperation**

In order to enhance the existing collaborative efforts among African nations in the digital domain, it is imperative to promote the alignment of policies, the utilisation of shared infrastructure, and the coordination of initiatives. These measures are crucial for accelerating the process of digital transformation and fostering economic integration across the continent. The digital landscape of Africa is characterised by significant disparities in infrastructure, regulatory frameworks, and digital readiness. To address the gaps, it is imperative to emphasise the significance of regional cooperation. Such cooperation is instrumental in facilitating economies of scale and ensuring the uninterrupted flow of digital services and data across national boundaries. By collaborating, African countries can establish a unified digital market, enhance cybersecurity, and fortify their collective bargaining power on the global stage [23].

**The following are proposed actions:**

**Make Digital Policies and Regulations Work Together.**

- Collaborating through regional Economic Communities (RECs) is instrumental in aligning ICT policies, standards, and regulations.
- The implementation of frameworks such as the Policy and Regulatory Initiative for Digital Africa (PRIDA) is crucial for ensuring consistency and interoperability across member states.

**Develop the Cross-Border Digital Infrastructure.**

- It is recommended that investments be made in regional broadband networks, data centres, and other digital infrastructures that serve multiple countries.
- In order to enhance regional connectivity, it is imperative to leverage initiatives such as the Program for Infrastructure Development in Africa (PIDA). These initiatives facilitate the coordination of infrastructure projects, thereby promoting interconnectedness within the African region.

**Establish Regional Digital Platforms**

- The creation of shared digital platforms for e-commerce, digital payments, and public services is imperative to facilitate cross-border transactions and interactions.
- It is imperative to provide support for the development of the African Continental Free Trade Area (AFCFTA) digital trade protocols to streamline digital commerce across the continent.

**Case Studies:**

**World Bank's DE4A Initiative:**

The objective is to ensure that by the year 2030, all individuals, businesses, and governments in Africa are digitally enabled. This objective is supported by regional projects that enhance digital infrastructure and policy alignment.

**Expected Results:**

- The objective of this initiative is to enhance regional integration and foster a more cohesive digital market across Africa.
- The utilisation of shared digital infrastructure and services has been demonstrated to enhance efficiency and reduce costs.
- The enhancement of cybersecurity and data protection is achieved through the implementation of coordinated policies and practices.
- Accelerated digital innovation and economic growth are the result of collaborative efforts.

African nations can collectively surmount digital obstacles, leverage economies of scale, and establish the continent as a competitive entity within the global digital economy [83].

**Recommendation 7. Promote an Environment that Fosters Innovation and Research.**

To cultivate a dynamic ecosystem that encourages innovation and research. Innovation and research are critical drivers of economic development and competitiveness. In Africa, the cultivation of an environment conducive to innovation and research has the potential to address local challenges, generate employment opportunities, and stimulate inclusive growth.

**The following are proposed actions:**

**The Development and Implementation of National Innovation Policies.**

- The formulation of comprehensive policies that support Research and Development (R&D), intellectual property rights, and the commercialisation of innovations is essential.
- To achieve optimal alignment between national strategies and continental frameworks, there is a necessity to align national strategies with continental frameworks such as the African Union's Science, Technology, and Innovation Strategy for Africa 2024 (STISA-2024) [83].

**Create New Ways to Fund Innovation.**

- Create special funds to support new businesses, small businesses, and research projects with a lot of potential for new ideas [22].
- Give tax breaks and free money to companies to get them to invest more in R&D [15].

**Promote PPPs**

- It is imperative to promote collaborative efforts among governments, academic institutions, and the private sector to facilitate the funding and commercialisation of research outcomes.
- The utilisation of PPPs facilitates the distribution of risks and the mobilisation of supplementary resources for innovation [25].

**Expected Results:**

- The development of locally relevant technologies and solutions is predicated on the capacity for research and innovation.
- The increased commercialisation of research output has been demonstrated to contribute to economic diversification and job creation.
- The present study posits that the enhancement of collaboration among relevant stakeholders will engender a more cohesive innovation ecosystem.
- The enhancement of the global competitiveness of African economies is contingent upon the implementation of innovation-driven growth strategies [15].

The study has proposed seven key policy recommendations to assist African countries in enhancing the development and utilisation of ICTs. These recommendations are derived from empirical research findings and are designed to address the digital divide, promote economic growth, and ensure that all segments of society, including rural communities, women, and disadvantaged groups, have access to digital tools. The recommendations encompass a range of strategies, including investments in fundamental infrastructure such as electricity and broadband, measures to reduce the cost of the internet and devices, and initiatives to enhance digital literacy skills for employment and daily life. A comprehensive approach to community development necessitates the implementation of robust government policies, the provision of support for educational and training opportunities, and the establishment of community access centres.

In addition, the recommendations focus on building strong partnerships across countries in Africa, supporting local innovation, and creating fair rules for how digital services work. Regional cooperation can help countries share resources and connect better, while supporting innovation can lead to new ideas and job opportunities. These policy steps are not just about improving technology; they are about creating equal chances for all people to benefit from the digital world. If governments, private companies, and international organisations work together on these goals, they can make real progress toward a more connected, fair, and digitally strong Africa.

# 6 CONCLUSION

This thesis presents a thorough comparative evaluation of ICT utilisation across African countries, underscoring significant disparities in infrastructure, accessibility, and human capacity. The empirical evidence indicates that while some countries have made substantial progress, others continue to struggle with challenges stemming from systemic issues, including inadequate infrastructure, financial limitations, and insufficient digital literacy.

The regression analysis definitively showed that macroeconomic factors like GDP and literacy only partially explain variations in digital adoption. This indicates that social, policy, and contextual factors must also be considered. Countries with integrated national strategies, such as Kenya and Rwanda, exhibited better digital readiness. This underscores the importance of governance, regional coordination, and targeted investment.

In response to these findings, the thesis puts forward a set of seven targeted policy recommendations that are firmly grounded in the results of the analysis. The proposals presented herein are not merely abstract suggestions but are derived from empirical and spatial patterns observed throughout the study. These include the clustering of low-ICT adoption in Central Africa and the correlation between electricity access and digital inclusion. Each recommendation was meticulously formulated to address the gaps identified through regression, cluster, and descriptive analyses.

The proposed strategies aim to enhance foundational infrastructure, improve affordability, develop digital skills, and foster inclusive, regionally coordinated digital economies. These evidence-based policy pathways are intended to guide African governments and stakeholders towards more equitable and sustainable ICT development. Moreover, the evidence in this thesis will help policymakers and stakeholders craft data-driven strategies that maximise ICT's contribution to economic growth and social equity.

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